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BRIEFLY TOLD.

THE WORCESTER (MASS.) HEARING.—In our current item columns will be found a very full synopsis of the arguments had before the Massachusetts Board of Gas and Electric Light Commissioners, in the hearing on the petition of certain residents of Worcester asking that the Board order a reduction in the selling rate of the Worcester Gas Company, and that the Company also be directed to improve the illuminating value of the gas supplied by it. The hearing was a most interesting one, not only from the nature of the subject under review, but from the fact that two eminently able men—Col. Hopkins, representing the city as the latter's Solicitor, and U. S. Senator Hoar, representing the Gas Company—crossed verbal swords in the progress of the discussion, and each was quite up to the duties that the occasion imposed. Before going into any analysis of the respective arguments advanced, it might be well to say that the petition for a revision of the gas rate was supposed to proceed or spring from the public, which presumably was suffering from the impositions put upon it by the Gas Company, but in the light of the "general absence" of the public from the hall in which the hearing was held, it is only fair to assume that Mr. O'Connell—he was present—one of the originators of the movement, was really "the public"; and as Mr. O'Connell is somewhat known to fame as a local politician, we have a reason for his activity—his desire to pose with other contemporaneous politicians as a friend of the public and consequently a foe to the gas interest. In fact, the Gas Companies of Massachusetts have been shining marks in the past two years for the reformers, whose zeal was augmented by the peculiar conditions surrounding the gas supply of Boston. There, unfortunately, Mr. Addicks made the mistake of refusing to renew certain contracts for gas with prominent commercial establishments, which contracts had been made on the basis of $1 per 1,000 cubic feet, and at a time when the old Boston Company was contesting for the gas lighting supremacy of the city with Mr. Addicks' Bay State Company. They were time contracts, in some instances covering a period of two years or more. The proprietors of the commercial establishments were men of wealth and influence, and their combined effort was sufficient to enlist favorable legislation, which, after a severe struggle, culminated in the establishment (after a hearing before the State Board, which hearing was marked by much personal bitterness) of the dollar rate for Boston. The fixing of this figure (the attention of all Massachusetts was centered on the struggle) was the signal for general murmuring over the excessive gas prices in various cities and towns of Massachusetts, and the result was an avalanche of petitions to the Commissioners for hearings and so on. That the howl was an indiscriminate one is shown in the instance of the city of Lowell, where an appeal for the revision of the gas rate was at one time being urged in the local press, despite the circumstance that for years Lowell enjoyed the undisputed prominence of being the city of the country where gas was sold the cheapest. In any event, the Commissioners had their hands full—also their ears—attending to the appeals, some of which were decided favorably to the petitioners, and others were determined in favor of the Companies. Finally the Worcester case was reached, and while it may seem in bad taste to refer analytically to the hearing until the Commission has rendered its judgment, we likely will be excused for such reference on the score that the oddities of the trial were exceptionally marked. The day was the 11th inst.; time, shortly before noon; place, the office of the County Commissioners of Worcester; audience, the full Board, Mayor Marsh, Solicitor Hopkins, Superintendent of Street Lighting, Mr. Knight, Senator Hoar, the Rev. Mr. Gregson, Mr. E. R. Ware, Mr. O'Connell, one or two city officials other than those named, and some of the gentlemen interested in the management of the Worcester Company—but no populace, unless we take the Gregson-Ware-O'Connell contingent as standing for, by and of the people. Colonel Hopkins opened the case for the city by presenting a well-tempered argument to the effect that gas rates were too high in Worcester, simply be-

cause they were too high—and that is the gist of what he did say, unless we call attention to his admission that there was nothing to be said against the quality of the gas or the solvency of the Gas Company. To be sure, the Solicitor would be hard set to prove that the gas was inferior either in respect of candle power or impurity, since the year book of the Commissioners before whom the trial was being had shows the Company's product to have equalled in illuminating value 19.5 candles for the year, and that at no time had it shown a content of ammonia, sulphureted hydrogen or other impurity in excess of that stipulated by the law—the State illuminating standard is 17 candles. Mr. Knight, the Superintendent of Street Lighting, presented tables showing that, compared with the leading three Companies of the State, the rate at Worcester per 1,000 was $1.50 for 1893, as against $1.27 for the comparing points. Well; what did this show? If anything it showed that Worcester was better off respecting its gas rate than one of the "big three." We presume that the three points named in the comparison were Boston, Roxbury and Lowell. The Boston Company obtained an average rate of $1.25, on a total annual sale of 1,191,985,460 cubic feet; Lowell's average rate was $1.10 per 1,000, on a sale of 265,408,100 cubic feet; and Roxbury's average rate was $1.52 per 1,000, on an annual sale of 178,059,842 cubic feet. On the other hand, the average rate at Worcester was $1.50 on an output for the year of 146,883,000 cubic feet—by-the-way, according to our computation, the average sales of the three Companies selected figures out at $1.29 instead of $1.27. Nor do we think this way of handling the figures goes to prove that Roxbury charges or receives too high a price, for although its output is considerably greater than that of the Worcester Company, the former is badly handicapped in so far as the peculiar nature of the community which it supplies is concerned. For example, the Roxbury Company, although it has 117.9 consumers per mile of main, as against the Worcester Company's 90.1 consumers per mile of main, the average consumption per annum per consumer at Worcester is 26,585 cubic feet as against an average of 17,489 cubic feet per consumer at Roxbury. However, we submit that Mr. Knight's figures were no better arguments that gas costs too much in Worcester than was Col. Hopkins' *ipse dixit* to the same effect. Another thing that upset Mr. Knight's table was the admission that the "use of gas for street illumination had been materially reduced in Worcester of late years," although, for the matter of that, the same might be said with equal truth of Boston, Lowell and Roxbury. This brings the hearing stage down to the remarks of the Rev. Mr. Gregson, who, we should say, must minister to a congregation that is not of the millionaire type; for the burden of his complaint seems to have been to prove that he was not one of those favored few. Still, the reverend gentleman endeared himself in a tentative sort of way to gas men by his tacit admission that were he a millionaire he would use gas for cooking, even at the Worcester rate. The last of the objectors—for there is no reason to say that Mr. O'Connell graced the hearing save with anything than his presence—was Mr. Ware, who had a gas stove to sell, and the burden of his argument was that the Worcester Gas Company ought to reduce its rates so that his wares might come into greater use. So much for the petitioners. The Company's case was presented, with more or less ability, by no less a personage than United States Senator Hoar. In our opinion the Company could have made a selection for its defense without having gone so far afield as Washington, who would have had a better knowledge of gaseous politics than the Statesman (for a statesman he undoubtedly is) from the Bay State. Aside from this, his argument was temperate and humorous, if not unctuous. Still, gas men generally will agree with us that he was a trifle too humorous when he urged that a gas company ought to be protected now because of the possibility that competition with electricity would in the future (near or far) wipe it out of existence. No, Senator; no gas man fears such a condition. And in confirmation thereof we respectfully refer him to the foremost commercial electricians of the day; also, to the capitalists of the everyday sort who have put their money in electrical undertakings. We might even refer him to the electrical supply of Worcester, the managers of which would not be so contented were their relations to the Worcester Gas Company less harmonious than the existing ones. Looking the case over, the Gas Company seems to have had the better of the argument, although we suppose a sop will have to be thrown to Cerberus—who, in this instance, was not mighty.

THE headings of the tunnel in process of construction for the New York and East River Gas Company, were recently joined with great precision and correctness. So far as the actual use for which it was designed is concerned, much time will elapse before its completion; but as an engineering feat it reflects great credit on those who mapped out its details and carried them on to their present stage.

An Improvement in the Construction of Atmospheric Burners.

[A paper read by Mr. C. R. Voisey, M.D., before the Incorporated Gas Institute.]

At the invitation of the Council of the Incorporated Gas Institute, I am afforded an opportunity of speaking upon a subject not without interest and importance to its members—the defect of "down burning" or "lighting back" in the ordinary atmospheric gas burner, and the means which I and another have devised to obviate it.

Gas heating is a luxury and convenience which modern civilization has placed at our disposal. Its advantages for occasional and intermittent warming are manifest to all; and from a sanitary point of view, a properly working and well fitted gas stove is just as good as a coal fire. In the minds of many, however, there still survives a prejudice to its use, which is not founded on mere sentiment opposed to the supplanting of the time-honored coal fire with all its associations, by the introduction of any new device, but which is based on reasonable objections. In one case it is because it is noisy, in another because it is expensive. But the most pregnant objection of all is that it often emits a very unpleasant smell—an odor that is quite peculiar, and that is due to the burner having "lighted back."

By "down burning" or "lighting back" is meant, as you know, that the gas, instead of burning at the nipples, burns at the point where it issues from the gas jet or nozzle. Under these circumstances, it does not receive a sufficient supply of air for complete combustion. The heating power of the gas is considerably diminished, the "fuel" is blackened, and acetylene (C_2H_2) and carbonic oxide (CO) are formed. The former is responsible for the offensive smell; and both, in any degree of concentration, are highly poisonous. It would be difficult to realize that, under the conditions in which these gases are developed, they should ever accumulate in a room in such quantity or degree of concentration as to produce any very serious effects; but it is not unreasonable to believe that, if inhaled frequently or for long periods at a time in a dilute form, they must exert some deleterious influence, more especially in a constitution already enfeebled by disease. This erratic action of the burner is most often attributed to a faulty chimney, one in which there are intermittent down draughts—one just as unsuited for a coal fire as for a gas stove. But still they are numerous; and if a gas fire were used in one, there is not the least doubt that the ordinary burner is very likely to fire back with the first puff, and each succeeding puff will blow the incomplete products of combustion into the room.

It may be interesting to describe briefly what effects acetylene and carbonic oxide have on the human organism, and how they are produced. Sir Humphry Davy and others, experimenting on themselves, have proved that the inhalation of carbonic oxide causes headache, pulsation in the temples, giddiness, nausea, and great prostration leading to drowsiness and insensibility. This pathological sequence is occasioned by the direct action of the gas upon one of the cellular constituents of the blood—the red corpuscles. Internal respiration, as distinguished from pulmonary respiration, is effected by the agency of hæmaglobin—a highly complex chemical compound contained in the red corpuscles. This body is brought to the capillaries of the lungs in a reduced form, and it there absorbs and combines loosely with oxygen from the air. It is thence propelled by the heart to the various tissues, to which it delivers up the oxygen; and it is again conveyed to the lungs for a fresh supply. This alternate oxygenation and reduction of hæmaglobin is necessary to the vitality and functional activity of the tissues, and is continually taking place. Now, hæmaglobin has a similar power of combining with, and a greater affinity for, acetylene and carbonic oxide; and oxygen is only able to displace them from their combination with very great difficulty. The tissues of an individual breathing these gases would not only be deprived of some of their oxygen, but would in addition be supplied with injurious substitutes; and according as more or less of the hæmaglobin was rendered unavailable for respiratory purposes, so would the symptoms be more or less severe. I am not aware that such severe symptoms have ever been known to arise from the use of gas fires. But still atmospheric burners do very frequently light back, and chimneys are often faulty; and under these circumstances it is no uncommon experience to hear complaints of headaches and nausea as a result. The symptoms are due to a palpable and clearly understood defect, which detracts from the value of the stove; and a knowledge that these are possible consequences of its use does considerably restrict the sales. There is every reason, therefore, why efforts should be made to remedy it.

"Lighting back" in the ordinary burner may be caused by: (1) Down draughts playing upon the nipples and acting in a direction opposite to the currents of mixed air and gas. "Lighting back" only occurs when

the force of the draught is sufficiently strong to reverse the direction of the current, and to blow the flame down the nipples. The ordinary burner is fairly safe when working full on at a pressure of $\frac{1}{10}$; but as the pressure is lessened, a proportionately less force is required, and at $\frac{4}{10}$ or $\frac{6}{10}$ it easily lights back. (2) Draughts playing upon the air inlet and acting in the *same* direction as the current of mixed air and gas. This would appear to be by far the most common cause in operation; and it is extremely fatal to the efficient action of the burners at all degrees of gas pressure—almost as fatal at $\frac{1}{10}$ as at $\frac{4}{10}$. In some cases the draught comes from the chimney, but more often from the front of the stove, and is caused by a passing dress or other moving object, the opening or shutting of a door, etc. In whatever way arising, the result is the same—the draught increases the velocity of flow of mixed air and gas, the percentage of air in proportion to gas is increased, the mixture is more readily explosive, and on the cessation of the draught the recoil draws the flame down the nipples and ignites the mixture. (3) Sudden variations of gas pressure. The ***modus operandi*** in this case is much the same as in the last. There is a temporary acceleration in the flow, succeeded by a recoil, and the flame is drawn into the mixing chamber. (4) Too small a gas jet or nozzle, or choking of the nozzle by dust or soot. (5) Insufficient gas, with too large a percentage of air.

The most important defects of the ordinary burner are: (1) That it is liable to be "lighted back" by various disturbing influences even when "full on." (2) That it is incapable of working safely with a less supply of gas than is represented by a $\frac{4}{10}$ pressure. (3) That it does not admit of the heat supply being regulated to a sufficiently low point.

Efficient action of Bunsen burners for laboratory purposes is secured by means that are not applicable to the atmospheric burners that are used in gas fires. The interposition of a piece of fine metal gauze in the course of the air and gas current, or the regulation of air so as to preserve a certain fixed ratio between it and the amount of gas passing, are both objectionable—the former because the meshes are liable to become clogged by dust, and the velocity of the flow impeded so as to cause very sluggish flame; and the latter because it is complicated and liable to get out of order.

Without some such means, it is recognized to be impossible to sufficiently lower the point of minimum pressure; and hence all further attempts in this direction have been abandoned, and attention has been given to the development of the idea of using only a fractional part of the total number of flames, working at a pressure from the acquired minimum of $\frac{4}{10}$ upwards.

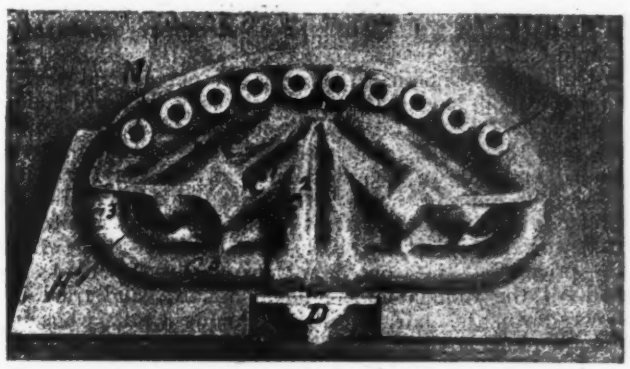
The outcome of these attempts are: (1) The "Duplex" burner; (2) the series of separate Burners each provided with a separate tap, as recommended by the Lancet Commission.

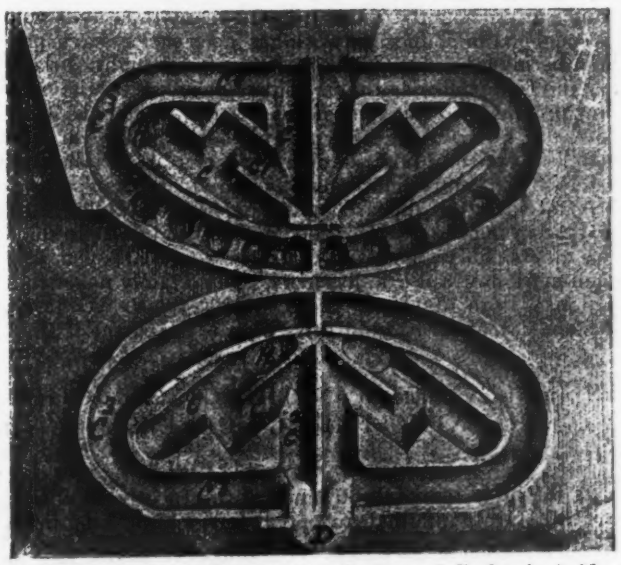
A means has recently been discovered of reducing the point of minimum safe pressure from $\frac{4}{10}$ to between $\frac{3}{10}$ and $\frac{1}{10}$, and is applied in the burner which I shall now attempt to describe. In the early part of last year I was experimenting to determine whether it would not be possible to apply to the ordinary gas fire burner the principle of the proportionate admission of air and gas in a manner not previously attempted. One experiment was as follows: A central air chamber (fed by two lateral tubes) was attached to the air inlet of the burner, so as to embrace the tube and tap supplying the gas. On the plug of the tap were fixed two "wings," so arranged that when the gas supply was turned low, the "wings" should at the same time diminish the air supply proportionately. Though the outcome of the experiment was unsatisfactory, in that what was expected was not fully realized, it was satisfactory and interesting in that it demonstrated the fact that, though the burner did "light back" by a down draught with a slight explosion—but only after a much more severe test than is ordinarily required for the purpose—the flame subsequently righted itself at the nipples of the burner. After a little reflection, it occurred to me that the explanation of this phenomenon is that the carbonic acid resulting from the explosion in "lighting back" was collected in the central chamber, and was afterwards sucked by the injecting action of the flame over the nozzle, and so extinguished the flame. Subsequent experiments were directed to apply this fact to the fullest advantage, and to neutralize the other causes of lighting back.

The burner may be described as being compounded of two separate and similar burners placed side by side, to the air inlets of each of which is attached an arrangement of tubes—all the parts being in the same horizontal flame and cast in one piece. The chief features of the invention are: (1) The dual character of the burner proper; (2) the attachment and peculiar arrangement of the tubes through which the air enters to the mixing chamber.

For the purposes of description, it will be convenient to speak of only one-half; for what is said of one is equally applicable to the other. Each half is, roughly speaking, horseshoe shaped. Projecting from one end of the shoe, at the point where the gas and the air first come in contact, and at right angles to the direction of the mixing chamber, is the first part of the air tube C^2, extending almost to the other end of the shoe. It there communicates at an angle of about 45° with the second part of the tube C^1, which extends backwards in an oblique direction to about the middle of the concavity of the horseshoe. It there communicates with the third part C, which has a direction parallel to the second part C^1, and stretches in an oblique direction completely across the concavity. This third part has two openings to the air H and H^1—one (H) at the front on its under surface, the other (H^1) at the back of its upper surface. The gas is supplied to the two halves of the burner by the forks of the Y-shaped nozzle or jet D.

This construction was especially designed to obviate, as far as possible, the disturbing influence of draughts either upon the nipples or the air inlets; and it does so in the following manner: If a down draught from the chimney plays upon the nipples (cause 1), it blows the flame into the mixing chamber. A slight explosion then occurs, and the products of the explosion are blown into the tubes C, C^1 and C^2. The gas is now for the moment ignited at the nozzle; but the injecting action of the flame subsequently draws the carbonic acid stored in the tubes over the nozzle, and, extinguishing the flame there, allows the burner to right itself.





$C\ C^1\ C^2$. Parts of Air Chamber for Storage of Carbonic Acid, etc.
C^3. Mixing Chamber. D. Gas Jet or Nozzle.
$H\ H^1$. Air Inlets. N. Nipples.

As already stated, the efficient action of the burner is most often disturbed not so much by draughts acting ***against*** (cause 1), as by draughts entering through the air inlets, and acting in the *same* direction with the current of mixed air and gas (cause 2). The outermost part of the air tube C, besides assisting in the storage of carbonic acid, has a special function of its own in counteracting this latter influence. Draughts or compressed air entering by either the upper or lower openings $H\ H^1$ rush straight through the tube C from the area of greater to the area of lesser pressure, diminishing instead of increasing (as they do in the case of the ordinary burner) the amount of air admitted to the mixing chamber C^3. So long, therefore, as they continue to act, the flame is luminous; but the burner does not "light back."

On testing the burner, it was found that not only had the means

adopted neutralized the influences causes 1 (down draughts) and 2 (draughts on the air inlet), but also rendered it more tolerant of causes 3 (varying pressures) and 5 (too little gas and too much air). The only remaining cause is No. 4 (too small a nozzle). This is either a consequence of negligence in manufacture or of deposition of carbon from the burner having been frequently lighted back. The former is remediable by care, and the latter does not occur in the case of the burner described.

The new burner is designed and constructed to resist all and only such disturbing influences as are likely to be met with in actual everyday use; and it is fairly claimed that it succeeds in doing this in a remarkable degree.

1. It is practically absolutely safe when working under pressures of from 2-10ths upwards. The lowering of the minimum point of safe pressure admits of a more extended and gradual regulation of the temperature than is possible by the duplex burner, and dispenses with the necessity of using either it or the system of separate burners each with a separate tap, as recommended by the Lancet Commission. It is somewhat difficult to explain how the lowering of the minimum point of safety has been brought about. The flame from a supply equal to a pressure of 2-10ths has all the appearance as regards color of that from a supply equal to 1 inch—it is neither more nor less luminous. The probable explanation is that the resistance offered by the shape of the tube to the entrance of air does proportion its amount to the quantity of gas entering the burner, and that this proportionate admixture is preserved through all degrees of pressure supply from 1-10th and upwards.
2. It is quiet in action.
3. It is simple in construction and inexpensive to make.
4. Any degree of power can be obtained.

The precautions necessary to be observed in fitting the burner in the stove or grate are: (1) That neither inlet of the tube *C* is covered; (2) that the way through the tube *C* is clear and unimpeded; (3) that the aspirating action of the flue or chimney is not allowed to exert its influence on the upper and posterior air inlet.

If the tube or either opening is occluded, the draught is no longer able to rush through and diminish (so long as it continues to act) the air supply to the mixing chamber, but would enter C^1 and C^2 and cause "lighting back" as readily as in the case of the ordinary burner. If the aspirating influence of the flue is brought to bear on the upper air inlet, the air entering by the lower opening would be drawn straight through the tube, and, little or none entering the burner, the flame would become luminous.

There is one other matter upon which I should have liked to make a few remarks and to have heard discussed—that is, as to how far the process of combustion of gas is modified by the condition (under which it is burnt in a gas fire) of passing through red hot fuel. The subject is an important one, but time will not permit of my dealing with it now.

The Practical Prevention of Smoke in Boiler Firing by the Use of Producer Gas.

By Mr. W. H. Blauvelt.

Steam power has grown to be such an important factor in the needs of our daily lives that the number of boilers used has multiplied enormously even during the past decade. Perhaps the increase has been most rapid in the large business blocks, hotels and similar places located in the most crowded parts of our cities. This fact has done a great deal to force the attention of the public to the subject of smoke and its prevention; for, unlike the manufactories and mills, which are usually located on the outskirts of the town, these boilers belch forth their black clouds in its very midst.

While it is very desirable that the firing of boilers should be smokeless, it is at the same time important that it should be economical, as smoke preventing devices will receive scant encouragement from those who are to use them if they entail increased expense for fuel or attendance; and, in fact, it is the economy of any proposed method that will alone determine its acceptance by the steam user. We have then, in considering the use of producer gas for firing boilers, to first discuss the question of its economy in comparison with the ordinary methods of firing; and, second, whether the prevention of smoke can be accomplished by its adoption.

First, as to economy. It is often said that the losses incident to gasification are so great that gas can never be an economical fuel for this work, that the heat generated in burning the carbon to carbon monoxide is lost in the producer, and that regeneration cannot be used to repay these losses, as is done in the regenerative furnaces for steel making, etc. While these statements may have been true with the earlier types of producers and in former practice, they no longer obtain with present methods. Let us see what the losses actually are, and whether there are any corresponding ones in direct firing that will balance them. For this purpose let us assume the gasification in a producer of the most modern type of a coal containing, say, 55 per cent. of fixed carbon, 32 per cent. of hydrocarbons and 13 per cent. of water and ash.

In all modern practice steam is mingled with the air used for blowing the producer, the principal object being to absorb the heat of primary combustion (burning carbon to carbon monoxide), which dissociates the steam, the hydrogen being set free and the oxygen combining with carbon to form carbon monoxide. A secondary object is the softening and breaking up of the clinkers formed. It is found that somewhat less than 8 per cent. of steam, by weight, is about the maximum amount practicable; in this mixture one-fourth of the oxygen needed for the combustion in the producer is supplied by the steam, the other three-fourths coming from the air. Assuming that 11 per cent. of the fixed carbon is burned to carbon dioxide, and that the above mixture of steam and air is used for blowing the producer, 1 pound of the above coal will give the following gas:

	Pounds Gas.	Heat Developed. British Units.	Heat Absorbed. Thermal Units.
0.05 pound carbon burned to CO_2.....	0.183	725	....
0.50 pound carbon burned to CO.....	1.167	2,200	....
Total.....	....	2,925	
0.32 pound hydrocarbons (distilled)*...	0.320	....	....
0.88 pound oxygen needed, of which 0.2 pound derived from H_2O liberates H.	0.025	....	1,550
0.60 pound oxygen derived from air is associated with N.....	2.007	....	....
Total pounds gas from 1 pound coal....3.702 raised to 600 F.			540
Total.....			2,090

*In this discussion the hydrocarbons are assumed to be methane (CH_4).

The total energy in 1 pound of the above coal is 14,375 B.T.U. The difference between the heat developed and the heat absorbed (the loss by radiation, etc.), is 2,925 — 2,090 B.T.U. = 835 B. T. U. = 5.8 per cent. of the total energy of the coal. This estimate of loss is practically the same as that made by Taylor and Campbell in their discussions of heat reactions in the producer ("Transactions" A.I.M.E., vols. xviii. and xxii). The energy expended in blowing the producer amounts to about 2 per cent. of the energy in the coal gasified. Thus, with the most economical producer practice the gas enters the flue with a loss of 7.8 per cent. charged against it. In a plant for firing boilers the producer should be as near as possible to the combustion chamber, and the additional radiation in this short flue would be hardly anything. If the gas lost 25° in temperature, it would amount to 0.2 per cent., making the total loss due to the gasification 8 per cent. In this estimate I have not considered the losses common to grate flues and producers, such as the carbon and sensible heat lost in the ashes, the heat expended in volatilizing the hydrocarbons, etc.

Now let us consider what are the relative values of the gaseous and solid fuels in the combustion chamber of the boiler. It is well known that gas can be burned with practically no more than the theoretical amount of air, if care is taken to mix them intimately. But it is shown by Rankine and others that at least twice the theoretical quantity of air is necessary to properly burn solid fuel, in order to provide for the proper dilution of the gases of combustion, which would otherwise prevent the free access of air to the fuel. Much more than this excess is actually used in practice, especially when we consider the enormous quantities of air that enter the doors during the operations of stoking and cleaning the fire. But for this comparison we will accept Rankine's figures, 24 pounds of air to 1 pound of coal.

To burn the gas from 1 pound of coal (assuming it to be of the composition given in the above table), 9.3 pounds of air are needed. Assuming for simplicity's sake (and as this factor has no bearing on the case) that the walls of the furnace radiate no heat, all the heat generated is absorbed by the boiler, except that escaping up the stack in the waste gases, which we will assume have the moderate temperature of 600° F. It will at once be seen that the loss from this cause is much greater in the case of the solid fuel, owing to the greater volume of the gases. The amount of the loss is shown below.

When gaseous fuel is burned, the gas enters the combustion chamber at 600° F., as before shown, and the air at an average of say 50°. There-

fore the total loss of heat in the combustion under a boiler of the gas from 1 pound of coal is that absorbed in raising the 9.3 pounds of air from 50° to 600°, the temperature of the stack gases. This loss amounts to 1,279 B.T.U., or 8.8 per cent. of the total energy of the coal. Adding this to the loss in the producer and flue gives 16.8 per cent. as the total loss under the assumed conditions. In the case of the solid fuel, both coal and air enter the combustion chamber at the temperature of the atmosphere, which has been assumed to be 50°. We have, therefore, 24.87 pounds of waste gases to be raised 550°. (No account has been made of the moisture in the coal in either case, as its action is the same in both). This absorbs 3,420 B.T.U., or 23.8 per cent. of the total energy in the coal. The loss is, therefore, 7 per cent. greater by the use of solid fuel than when gas is the fuel. Or, 11,960 B.T.U. are available for work in a pound of coal, when burned as gas, and 10,953 B.T.U. when it is used direct. The gas would, therefore, do 9.2 per cent. more work than the solid fuel. These figures show only the losses essential to the two methods and which no care in manipulation can overcome. In practice there are other losses, such as that of carbon falling through the grate and the escape of unconsumed gases; these losses are always much greater in grate fires than in well conducted plants. The great variations in a grate fire in the proportions of air and combustible as fresh fuel is thrown on and then burns down to bright coals is a serious cause of loss that is entirely lacking in the gas fire which is properly handled.

That the results of practical tests comparing gas with direct firing vary greatly, often showing much larger and sometimes even less economy in favor of the gas than that shown above, is due to the relative approximations made to the above examples, which are of the best attainable practice. When hand fired boilers are badly managed the economy obtained from gas, properly applied, is very large, sometimes as high as 30 to 35 per cent. On the contrary, when gas is carelessly and incorrectly applied to boilers previously fired by hand in the best manner, it may be that no saving will be effected.

The above calculation has shown what a large amount of heat is lost in the chimney gases, even when they escape at no higher temperature than 600° F. Gas fuel readily enables a portion of this heat to be returned to the combustion chamber by using the waste gases to preheat the air for combustion. The temperature to which the air can be raised depends upon the opportunity the arrangement of the plant affords for introducing an efficient heating apparatus. But in the case above assumed, if the incoming air could be heated to 325° (which could readily be done) one-half of the chimney loss, or 4.4 per cent. of the total energy in the coal burned as gas, would be saved, and the total loss reduced to 12.4 per cent., against 23.8 per cent. loss with the solid fuel.

Not the least among the advantages of gaseous fuel is the unquestionable fact that by its use it is much easier to maintain a maximum of economy, and the personal feelings of the firemen do not introduce so large a variable into the problem as in the ordinary method of hand firing. Therefore, gas-fired boilers usually give a much greater saving over those fired with coal than is shown in the above comparison. Tests made at various times and with widely different fuels show economies varying from 10 to 30 per cent., and, in almost all cases, a materially increased rate of evaporation is obtained. Another important advantage is that the steaming is much more regular, especially when the plant is larger. Then all the producers feed into a common gas main, and this supplies all the boilers, so there is practically no variation in the supply of gas. The life of the boiler is materially greater with the gaseous fuel, as it is free from the strains caused by the frequent cooling due to the enormous quantities of cold air that rush in whenever the fire doors are open for the stoking and cleaning necessary when burning solid fuel. Just to what extent these strains shorten the life of a boiler it is impossible to estimate, but it is acknowledged that their effect is serious.

On the other side, the solid fuel has the advantage of the radiant heat of the bed of coals as it glows on the grate after being fully coked. Just what this amounts to is not known, nor have we been able to measure its evaporative value. It is undoubtedly true that more evaporation per square foot of surface can be obtained by a coal fire when there is a sufficiently strong draft than by gas, but only at a largely increased expenditure of coal, in proportion to the duty done. Notwithstanding the undetermined value of the radiant heat from the solid fuel, numerous practical tests show the economy to be in favor of the gas, and this is a proof much more satisfactory to the steam user than the most elaborate and convincing calculations on thermal energy and absorption. As a result of our investigation into the economy of the subject, we find, therefore, that the advantages are on the side of the gaseous fuel for firing boilers. Its use secures more duty per pound of coal, insures a higher average of good work, more regular steaming and the life of the boiler is materially prolonged.

Turning now to the other branch of our subject, our first inquiry is, what is smoke, and how is it formed? Although smoke in general may be composed of a large number of gases, vapors and finely divided solids, we are considering only the smoke from bituminous coal; this may be defined as that portion of the products of combustion of the hydrocarbons in the coal which is visible—viz., solid carbon in a finely divided state, or soot, and volatilized but unburnt hydrocarbons.

Many hydrocarbons, when heated to suitable temperatures, are decomposed with formation of a new hydrocarbon and solid carbon in a fine state, which, unless there is present a supply of air at a proper temperature for its combustion, passes off as soot. Smoke may also be formed by hydrocarbons while in combustion striking against a cool surface, which lowers the temperature below that at which combustion can be sustained, and the flame is "put out," with the production of smoke as the result.

A third cause is the distillation of the hydrocarbons without alteration or even partial combustion. It is this that gives the yellow tinge to smoke, and the greasy quality, which is one of its most disagreeable features. From the point of view of thermal economics, the formation of smoke is not of such serious importance as many imagine. In ordinary cases the actual loss of combustible amounts to but a few per cent. of the energy in the coal; in its denser forms it is important because it is the indicator of seriously imperfect combustion, and because carbon is visibly wasted. The attempt should be, therefore, to prevent its formation rather than to "consume" it, at the expenditure of mechanical or thermal energy.

The causes for the formation of smoke serve to indicate the means for its prevention. The deposition of solid carbon from decomposed hydrocarbons and the escape of unburnt volatilized hydrocarbons may both be prevented by their intimate mixture at the moment of combustion with the proper amount of air, preferably preheated, so that each particle of carbon or hydrocarbon may find oxygen adjacent to it for its combustion. The "putting out" of the flame by its contact with cold surfaces may only be overcome by permitting the combustion to be nearly complete or at least thoroughly established before the gases are allowed to impinge upon the boiler shell or other cool surface. While it is very difficult to carry out these conditions with solid fuel, gas easily lends itself to them, and by their proper application all smoke can be prevented from gas fired boilers. The mistake usually made in applying gas to boilers is the attempt to imitate the conditions of a solid coal fire, it being forgotten that the gas is employed in order to overcome weak points essential to the use of solid fuel.

In some applications of gas recently made to return tubular boilers by the writer, a careful use of the above principles in the light of previous less successful experience resulted in the prevention of all smoke and in an increase of the evaporative capacity of the boilers of over 12 per cent. as compared with the results from the same coal burned on the grate. At the same time there was a saving of about 15 per cent. in the amount of coal used. The air for combustion was not preheated, and the temperature of the waste gases was 700° or more, as the boilers were too short for the most economical work. Had hot air been used, of course this high stack temperature would not have been a source of serious loss.

The mixture of the gas and air was made as prompt and perfect as possible by a special arrangement of the ports, and inflammation was thoroughly developed in a brick chamber below the boilers. This was so arranged that but little more than the products of combustion reached the shell of the boiler, and at the same time the temperature at which combustion took place was kept high by the reflected and radiated heat from the walls of the chamber. For successful boiler firing it is essential that the mixture of gas and air should take place as soon as possible after they enter the combustion chamber. Frequently they are introduced in parallel streams, but even if these streams are small, the gas and air often travel quite a distance with but little mingling of the currents. This is an important point.

The arrangement referred to above provoked some criticism from onlookers, as the fire seemed too far from the boiler to those whose idea was that the conditions of a coal fire should be imitated as closely as possible. But the entire absence of smoke and the duty obtained from the coal, both as to economy and rate of evaporation, were sufficient arguments in proof of the correctness of the principle employed. One point noted during this test was that it was practically impossible for the firemen to make smoke except by the most gross inattention to the relative proportions of air and gas.

I know of no other method of burning fuel which presents so practi-

cal and reliable a solution of the smoke problem ; for it not only makes no smoke when carefully operated, but is equally free from that fault when the fireman's vigilance is relaxed, and it adds to this the advantage of economy over the methods in general use. To make gas available for the steam plants in the business parts of our cities a special producer would, in many instances, be required of a design suited to the limited quarters it would have to occupy, but this would hardly be a serious obstacle. Smoke abatement in cities is occupying so much public attention that stringent legislation on the subject is sure to come, and much annoyance and loss to steam users may be avoided by putting themselves beyond liability while there is ample time to make the change.

The Application of Coal Tar for Making Gas.

[A paper read by Mr. C. S. Ellery before the Incorporated Gas Institute.]

The extreme fluctuations that have taken place in the tar trade during recent years, and the low prices now ruling for the products of distillation, afford ample evidence that the market stands in need of fresh outlets for at least some portion of the tar. This necessity is becoming more urgent year by year, because of the continued increase in the quantity of coal carbonized in processes of which tar is a residual product. Some figures taken from the parliamentary returns as to gas undertakings will make this clear. In the year 1882 the quantity of coal used in the gas works of the United Kingdom was 6,365,300 tons ; in the year 1892, it was 11,219,300 tons—showing an increase in ten years of 4,854,000 tons. Estimating the yield of tar at 1 cwt. per ton of coal, it follows that the production in 1882 would have been about 318,-264 tons, and in 1892, 560,964 tons—an increase in ten years of about 242,700 tons.

Indications are not wanting that this rate of increase will continue. Gaseous fuel seems to be superseding coal for domestic and commercial purposes. The economy and convenience, not to speak of the avoidance of smoke and soot, which result from the use of gas engines, stoves and fires, tend to develop a larger consumption of coal for gas making purposes, and consequently augment the production of tar. Unless, therefore, some methods are devised to lessen the pressure to sell, the prospect of any substantial improvement in the price of tar seems to be very remote.

In looking for relief, attention is naturally directed to the existing applications of coal tar. Of these, distillation obviously stands first. But the trade reports of tar products do not encourage much hope of any developments likely to remove the cause of depression. Of the employment of tar without distillation—such as in the preparation of asphalt and roofing felt, or as a paint in the preservation of wood, iron and building material—little need be said in this paper. The quantity thus utilized being comparatively small, mention is mainly made in in the hope that some fresh hints may be drawn from the experience of those who possess special knowledge of such industries.

Relief has been sought, at times of extreme depression, by utilizing some portion of the production for fuel. This effected the one result of temporarily relieving a glutted market; but there are grounds for the contention that to burn a valuable "complex mixture of chemical compounds," as tar has been well called, simply to clear it off the market, is, to say the least of it, an extravagant proceeding. It further involves great anxiety and worry in controlling furnaces and securing regular and complete combustion, besides throwing the unused coke on to a market already fully supplied.

At this point, it may be well to give the percentage of products obtained from a sample of ordinary tar :

	Per Cent.
Ammoniacal liquor, gases and loss	9.2
Light oils	1.4
Second light oils	1.6
Creosote oils	20.5
Anthracene oils	6.9
Pitch	60.4
	100.0

This analysis cannot be relied upon for other than the particular sample tested. On the contrary, the composition of tar will be found to vary, not only in different works, but also in the same works, if taken at different parts of the plant or under altered conditions. The coal may have something to answer for in this matter, but the point emphasized here is that in most cases tar contains more or less of the valuable hydrocarbons shown in the analyses, which, in the author's opinion, should be put to a better use than providing fuel for furnaces.

In the year 1880, Mr. Greville Williams gave, as the result of a series of experiments, the startling fact that gas, in passing through a tower filled with clinkers saturated with tar, was injured to the extent of two candles. Admitting that the illuminating power of gas is not injured to this extent in the ordinary process of manufacture, it will probably be conceded that, in some works at least, the tar is, to a greater or less degree, further enriched, at the expense of the gas, on its passage through the foul mains. It would be rash to fix any exact proportion, but in most tars as sold there would probably be little short of 40 per cent. of compounds capable of conversion into illuminating gas. It will also be noted that a considerable quantity of ammonia is present. This clearly is lost to the gas company, whether the tar be sold or used as fuel.

These considerations lead to the question whether it may not be both desirable and profitable at all gas works to utilize a portion, and in the case of some works, the whole of the tar produced, as a substitute for coal in the manufacture of gas. Few gas managers have, at one time or another, escaped the fascination of this idea of gasifying tar ; and yet, though good work has been done and interesting information published—notably in connection with the Peebles process—little seems to have been effected beyond the experimental stage. The results embodied in this paper represent merely what has been accomplished at one works ; but the author desires to make quite clear his opinion that very much yet remains to be found out. With this idea in his mind, he consented to open a discussion to-day among those who are working in the same field of research, in the hope that thereby the desired end may be more speedily reached. To narrate all the experiments, failures and disappointments, would occupy too much time. Suffice it to say that a large number of tests were carried out before the stage was reached which is described in this paper.

The apparatus employed is a small plant erected for testing coals. Several forms of retorts were tried, but most of the work has been done in a Ω-shaped iron retort, 18 inches by 14 inches and 9 feet long. It may, and probably will be, that further experience will suggest modifications, but up to the present it has been found convenient to conduct the experiments with plant suitable for carbonizing either coal or tar, as occasion required. The retort is set at an angle, having a fall of about three inches from front to back, and a sloping tile is fitted on the mouthpiece, to prevent any accumulation of tar behind the lid, The ascension pipe was originally connected with a dip pipe to a seal box, which served the place of an hydraulic main. After a time, this seal box was dispensed with, and the pressure in the retort regulated by means of a governor attached to the exhauster engine. The condenser is a simple series of pipes fixed on brackets against the retort house wall, having a slight inclination throughout, so that all products of condensation return to the retort. The exhauster is placed between the condensers and washer, and after passing this and the purifier, the gas is measured in a station meter and stored in a special holder.

It was soon discovered that the destructive distillation of tar could not be successfully carried out in a single operation. The effect of subjecting tar to a heated surface is to liberate not only gas, but a more or less considerable quantity of oils, according to the internal temperature of the retort. Experience shows that these oils are capable of producing the richest gas. The plant is accordingly arranged so that all condensed vapors gravitate back to the retort, and that without coming to rest in the hydraulic main or siphons, because of the tendency of some of the paraffines to solidify if permitted to fall below a certain temperature.

All the tar used is measured from a small store tank, fitted with float having a graduated stem. In the earlier tests, the tar was run into the front of the retort through a ¾-inch tube, connected into the ascension pipe. The oils passed in the same way. The effect of this was to lower the temperature in the front of the retort where the two streams flowed in ; whilst it was unduly high at the back. To correct this, the tar is at present run in at the back end of the retort, and a portion of the oils continues to flow down the ascension pipe. This works satisfactorily so long as the stream of tar is regulated to produce oils in sufficient quantity at the top of the ascension pipe. If the inflow of tar is insufficient, free carbon is produced, with most unpleasant results—stopped pipes, with all their attendant evils in most aggravated forms. This trouble is also experienced if the tar or oils are brought into sudden contact with an overheated retort. It has been obviated by throwing a few pounds of dust coal into the retort before running in the tar. Water also has been used in conjunction with the tar, and it is a question whether superheated steam or water will not ultimately play a more important part in this process.

There remains yet the commercial side of the subject. Sufficient has been said to show that the yield of gas will vary between extremes somewhat widely separated. When these experiments were commenced, the quantity of gas produced was small and of inferior quality. For long months, it looked as if 10,000 cubic feet was the best obtainable from a ton of tar; but later returns have improved, so that the yield has reached as much as 20,000 cubic feet. But in no case could such illuminating power—25 candles—be obtained as is reported from experiments elsewhere. The difference is possibly to be found in the quality of tar. Taking the average of a large number of tests, it may be assumed that an ordinary sample of tar will yield at least 16,000 cubic feet of 15-cande gas per ton of 200 gallons. In addition to gas, the destructive distillation of tar results in two other products, coke and ammoniacal liquor. The coke is practically free from ash, and, if produced at a proper temperature, it should be equal to best foundry coke. The quantity varies, but may safely be set down at 10 cwt. per ton of tar. The ammonia is estimated as equal to the production of 16 lbs. of sulphate of ammonia per ton of tar. Various methods may be adopted for arriving at a fair valuation. The following figures are based upon the values obtaining at the works where the experiments are being conducted; but prices will doubtless vary in different localities. It is hoped that sufficient data are given in the paper to enable others to arrive at a valuation after having analyzed the tar to be used. To get at the money value per ton of tar:

16,000 cubic feet of gas are taken, at 9d. per 1,000 feet =	12s.
Ammonia..... ...(say) =	1
Coke 10 cwt., taken at 16s. per ton..... =	8
	21s.

Assuming 21s. as the present value of tar if used for gas making, and taking 15s. as the market price of tar, there is a margin of 6s. per ton in favor of applying it to the manufacture of gas.

But other and larger considerations must be taken into calculation. By using up some portion of the production in this manner, the market would be relieved, and prices of the tar and other products should return to something nearer their true value. The coal market also would be affected, more or less, according to the extent to which this employment of tar is carried. Assuming that one-half of the tar produced was converted into gas, the effect would be to throw 400,000 tons of coal onto the market.

To those gas works more or less distant from any tar distillery, also to small works without convenient railway accommodation, the application of tar to the manufacture of gas should have special interest. In these cases, carriage is a heavy item of expenditure; and it renders the tar almost unsalable, or at best a source of very small revenue. In such places, considerable advantage would be derived from converting the bulk of the tar into gas. Further, if tar was thus employed, a door might be opened for some modifications in the present method of carbonizing coal. As hinted at by the author at the meeting last year at Belfast, "high heats" are adopted in order to avoid the loss of hydrocarbons which otherwise would be taken away in the tar. The result frequently of carbonizing at such high temperatures, is the separation of free carbon, as is evidenced by stopped pipes and scurfed retorts. If the tar was re-used for the production of gas, it might be advantageous to work retorts at a lower temperature, and produce a richer tar, which would be useful as a substitute for cannel coal or other enricher.

Although the conclusions arrived at in this paper are based on figures obtained in a special apparatus with an iron retort, it may be of interest to state that, during the later months of last year, some tons of tar were carbonized in the ordinary clay retorts. The tar was run down the ascension pipe on to a fireclay tile fitted in the mouthpiece to prevent any accumulation of tar behind the lids; and it was possible to burn off a charge of about 40 gallons in six hours, as a makeshift, when coal was scarce, this was continued a short time; but for economical working iron retorts are desirable; and these should be fitted with sufficient condensing power to insure the return of the oils which escape from the retorts only partially decomposed.

In conclusion, it may be of interest to state that experiments have been made, and are being continued, to determine, first, the effect of passing a stream of coal gas through the retort in which the destructive distillation of tar is taking place; and, second, to ascertain the result of returning to the retort all the tar produced from an ordinary charge of coal, so as to gasify this product as well as the coal before the coke is withdrawn. Though no figures can be given at this stage of the investigation, yet sufficient evidence has been already accumulated to warrant the confident belief that more will be done with tar than has yet been accomplished; and at a future meeting it may be interesting to take up this subject for further discussion.

Building Stone.

In a contribution to the Indiana Geological Report, Mr. Maurice Thompson says that the qualities necessary to the best possible building stone are workability, durability and beauty. It must also be cheap. Workability includes in its meaning accessibility, a ready yielding to quarrying operations, the absence of refractory qualities under the hammer and chisel, and a texture and grain that will hold decorative finish. Stone that cannot be quarried readily has the disadvantage of great cost to begin with. If the "raw material" is expensive, the finished product must be costly. On the other hand, if Nature has so deposited her stores that the stone is easily taken from the quarry, still, if the material is refractory in the final cutting and finishing, no matter what may be its other qualities, it cannot be a very cheap material for the builder, as it will demand an over amount of expense and delay in preparation. Still less will it be desirable if it obstinately refuses to hold finish or decoration. Stone that comes from the quarry soft and yet somewhat tough, but hardening after a time, has the finest quality of workability. This renders it easy to quarry, very responsive to the tools of the cutter, and capable of taking easily and holding permanently the finish and decorative designs of the architect's specifications. It must be kept in mind, however, in examining stone, that if it comes from the quarry wet, and for that reason easily workable, it may again take up water after drying, which would be most objectionable; but if in the process of drying in the first place it passes through a chemical change which will render it ever afterward impervious to water, the quality is just what could be wished for in this regard. Usually an examination of the out-cropping surfaces of the stone in place will give a safe knowledge of its value as regards workability. Next, after the character of the stone, regard must be had touching the conditions of its deposit. Too much overlying matter, whether stone or earth, will usually make the quarry work very heavy and expensive. This overlying matter, technically called "stripping," is, as a rule, quite worthless, and must be entirely removed before the stone can be worked with steam channelers or other quarrying appliances, hence the necessity of a careful examination to determine its nature and extent in each case before opening a quarry.

Durability, as applied to building stone, includes every quality tending to make the material lasting and unchangeable after it is laid in a structure. These qualities are many, and often seemingly conflicting in their nature. Hardness, elasticity, tensile strength, power to resist the greatest crushing force, imperviousness to water and invulnerability to the attacks of air and its corrosive and disintegrative burdens, are some of the qualities, but not all. Evenness and homogeneity of composition, unity of substance, so to speak, and the power to resist extremes of heat and cold, are quite as necessary. It will be seen at once that chemical analysis must be relied on to insure the best knowledge of some of these requirements. Some otherwise good and durable limestones will become corroded and discolored, and have their integrity destroyed by the effect of sulphurous smoke from the burning of impure coals; others will be injuriously affected by the action of rainwater, and still others by the oxidizing power of the air. Some sandstones bear too much iron in their composition; others lack sufficient cohesion of the particles, while others yet are clayey or unequal in grain or texture. Every test of practical science should be given to stone before it is used in any building intended to be a permanent structure. As a rule, if the outcropping ledges are found to be infiltrated with water, which makes the outer surface constantly damp, the stone will not be good, for this would indicate that it would take up too much moisture in the wall. Still, it is often the case that an apparently over-hydrous stone will dry out permanently after it is quarried and cut. Many of the sandstones, notably the better qualities of conglomerate, are of this character, and so soft when first taken out that they may be cut to any rough shape with a common axe or hatchet, but hardening after a few days' exposure so that water will not affect them.

The elasticity of stone may be tested by sawing it into long, slender strips, say two inches square and three feet long, when, if it be quite perceptibly flexible, its elasticity is good. If such a bar be suspended so as to hang free by a string and is struck a light blow with a hammer, its evenness and solidity of fibre will be attested by a clear, sweet, metallic note, not unlike that of a fine bell or that of a well-tempered steel bar. As a rule, the best stone will break with a direct line of fracture, but it may be conchoidal or otherwise indirect and still be unobjectionable. Parallel lines of cleavage or of stratification are always favorable indications where other features are promising.

Resistance to crushing weight may be pretty safely inferred from

solidity of texture and evenness of grain, but it is always necessary before a final acceptance to submit the material to the severest tests of an apparatus for that purpose.

In examining sandstone with a view to building purposes, the outcropping, if there be any, should be carefully scanned with a view to discovering what effect long exposure to the atmosphere and the rigors of winter may have had upon it. If the stone has "weathered" badly this will be shown by one or another sign of disintegration or demolition, and a talus of fragments and sand will be found formed at or near the base of the outcropping cliff. Often the substance of the rock will show unmistakable evidence of inequalities of structural composition, such as horizontal cavities caused by the weathering out of seams or streaks that, on account of bearing too much iron, have oxidized and crumbled away. Such stone if used in a building would prove worthless, and therefore dangerous. It is often the case, as I have observed during a long experience in civil engineering, that public bridges erected by counties are rendered unsafe by having their piers and abutments constructed of this kind of stone, and that, too, in places where most excellent material lay at hand, and which a little knowledge of the nature of stone would have pointed out to the superintendent. Too frequently it happens that appearances of the most untrustworthy kind are relied upon where an ignorant person is set to do work which ought to be in charge of a skilled and well-informed engineer.

In judging of the probable durability of limestone, before subjecting it to any test of science, the same observations should be made as in the case of sandstone, with a view to ascertaining its weathering qualities. Any unequal discoloration of the face of the exposed ledge should be scrutinized carefully. Usually these are caused by the presence of iron in the composition of the rock. But limestones are much more injuriously affected by hidden faults of composition than are sandstones, and for this reason they demand a much more careful examination before any extensive quarries are opened. It is often the case that iron in limestone will do no more than discolor the outer surface on exposure to the action of air and rainwater; but even this is a serious defect when the stone is to be used in any structure wherein beauty is a chief object. For the rough masonry of ordinary bridges, and for the hidden foundations of buildings, a cheap and durable stone is what is most wanted, and in these discoloration is not a fatal fault.

Beauty, when applied to any building material, includes all the good qualities already enumerated, with the added value of a pleasing color or combination of colors, and a general effectiveness of appearance when the structure in which it is used has been completed. The variegated granites undoubtedly are the most beautiful of all building materials. Next to granite the red and brown sandstones are most pleasing to the eye, but the white, gray and blue limestones are very effective, and they have the advantage over granite in that they work much more easily in ornamentation, while they take figures in relief with far more clearness of outline than do the sandstones as a rule. Architects have long since discovered the pleasing effects to be produced by using different kinds of stones in the same building, placing each where its particular qualities will best serve the general motive of the design.

As a rule, all else being equal, the stone which holds its native color best will be most beautiful in a building, and of the stones which change color, that will be most desirable which changes least and evenly. Some of the gray sandstones, however, change color unevenly and give a striking and ofttimes picturesque cloudiness to the surface, which adds to its effectiveness of color in a wall. The nearly white limestones that take on by exposure a dark cream-brown hue, if they do not contain too much magnesia, hold that tint very well and are quite beautiful. As a rule, the presence of many large animal remains in a stone is objectionable on account of the tendency of such a composition to crumble; but where fossiliferous rock is durable it will usually be found very beautiful when cut, the organic remains bossing it over with variegations that greatly heighten its appearance. Stone which contains large fossils is not, however, the best for receiving raised ornamentations, such as figures in relief, no matter how durable and beautiful it may be, for the animal form will interfere with nicety of cutting and polish as well as with the regularity of the figures. Fossils will usually be found harder than the matrix in which they are set, but this is not always the case, for quite often the form is that of a hollow cast or impress filled in with material which crumbles easily. As a rule, fossils, though very hard, are but loosely set in sandstone, and often they are very large and rough forms of plants extremely silicious and refractory. Blocks containing these are to be avoided as probably worthless for building purposes, however valuable and interesting they may be from a scientific point of view.

Many very beautiful stones that are not durable when exposed to the weather are very valuable for the inside finishing of buildings, where they will last for ages, holding the finest tints of their coloring without perceptible change.

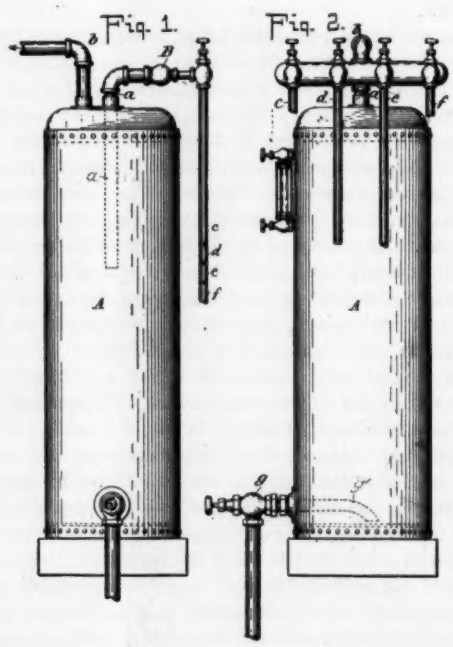
From what has been said above it will be seen that every owner of stone beds should, before going to the expense of opening quarries, have his rock beds examined by an expert, whose report should show all the defects as well as the good qualities of the material. Usually this can be done without any great outlay of labor or money, for the experienced geologist or engineer can quickly discover from the stone and its surroundings the nature of the deposit, and very simple chemical and mechanical tests will settle the question of strength and durability. There are beds of magnificent building stone lying undeveloped in many places, simply for the reason that the owners are not aware of the treasure they possess. In other places quarries are being industriously worked and the stone used in the erection of costly buildings, where in fact the material is wholly unfit for use on account of its lack of durability. I have examined many extensive structures whose stone was fast crumbling away. True, a few years will not show much decay, but in the long future the result will certainly be disastrous. The constant action of the atmosphere, the expansion and contraction consequent upon extremes of heat and cold, and the disintegrating effect of rainwater slowly but surely tell upon the integrity of the exposed parts.

Dixon's Apparatus for Separating Gas from Liquid Bye-Products.

On May 22d U. S. Letters Patent (No. 520,038) were granted to Mr. John A. Dixon, of East Orange, N. J., for "a new and useful apparatus for separating gas from its liquid bye-products," the inventor subsequently assigning the patent to the Safety Car Heating and Lighting Company. Using the words of the specification:

Figure 1 is an elevation of my apparatus for separating the gas and liquid. Fig. 2 is an elevation of the same taken at right angles to Fig. 1.

My invention relates to apparatus for separating gas from its liquid bye-products, and has for its object to remove liquid bye-products from



gas under pressure in a safe, convenient and economical manner, the liquid with its absorbed gas having first been collected in some suitable trap from which it is forced by the gas pressure.

My invention consists in the apparatus described herein, illustrated in the accompanying drawings and more particularly pointed out in the claim.

In the drawings herewith *A* is a closed vessel, preferably a vertical cylinder fitted at its top with an inlet pipe *a* projecting some distance into the cylinder so as to conduct the gas and liquid well into the cylinder and to prevent the gas passing immediately up through the vertical outlet pipe *b* and carrying the entrained liquid with it. The inlet pipe *a* is fitted on its outer end with a manifold fitting *B* so that any number of traps may be drained by the same apparatus, the pipes *c d e f* con-

ducting the liquid from the traps which collect the liquid bye-products and absorbed gas as they come from the compressors to the inlet pipe *a*. The outlet pipe *b* is connected with the low pressure storage so that all gas which comes over with the liquid may find easy exit thereto and be re-stored for future use. The vessel *A*, which may be of light material, as its connection with the low pressure storage prevents the accumulation of pressure, is fitted near its top with gauge glass and near its bottom with the draw-off valve *g* supplied with a curved pipe *g'* which projects inside the vessel with its inner end below the draining level of the valve so that a trap will be formed to prevent the passage of gas through the pipe *g'* should the draw-off valve be left open too long. As before stated, the pipes *c d e f* are connected with traps which collect the liquid bye-products with their absorbed gases; so therefore, in order to draw the collected liquid from any desired trap, as for instance the trap to which the pipe *e* is connected, the valve in the pipe *e* on the manifold fitting is opened and the liquid in the trap, together with an unavoidable amount of gas, is forced by the gas pressure into the vessel *A*. The liquid, after falling into the vessel *A*, immediately begins to evolve the gas carried along by it, which gas passes out of the vessel *A* by the outlet pipe *b* and is conveyed into the gasholder or low pressure storage. By allowing the liquid to remain quietly in the vessel for a while, any gas which was absorbed under pressure is liberated and finds its way to the low pressure storage as described.

Hitherto it has been customary to discharge the bye-products of gas manufacture from the collecting traps into open vessels or receptacles. By this practice the gas absorbed or held in solution by the gas tar or other bye-products is at once evolved into the atmosphere and gives rise to very objectionable odors.

My apparatus not only makes it possible to save the gas, but avoids the very objectionable odors which accompany the drawing of such liquids in the open air.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

In an apparatus for separating gas from gas tar, the combination of a vertical closed vessel, a manifold fitting *B*, a pipe *a* connected to the manifold fitting by one end and to the top of the vessel, and extending for some distance into and toward the bottom of the vessel, a series of pipes *c d e f* communicating with the manifold fitting and serving to conduct gas tar into the same from collecting traps, a gas outlet *b* leading from the top of the closed vessel, and a liquid outlet *g* at the bottom of the vessel having a curved pipe *g'* extending into the vessel and terminating below the draining level of the liquid outlet, substantially as described.

The Engine in Arc Light Stations.

By Mr. E. F. Williams, in *Electrical Engineering*.

The most reliable as a rule are the most satisfactory engines for arc lighting. They should be ready to start up whenever required to do so, and to continue running without accident until it is time to shut down. Of hardly less importance, however, in many localities, is economy in steam, and, following, floor space, attendance, first cost, repairs, etc.

How to best meet these requirements in the order of their importance is an absorbing subject ever present in the thoughts of the designers and originators of steam engines. The solution would be very much facilitated were there fixed conditions to meet. On the contrary, the advances in dynamo construction present, from time to time, new conditions, suggesting new combinations in the engine. When the arc dynamo of the future is permanently fixed upon as to form, dimensions, power and speed, engines will be designed that are right for the service. The "high speed engine" may not be known, the types being distinguishable by their makers' names, and as to whether horizontal or vertical.

Steam engineers are exerting their best efforts to meet the advances in dynamo construction with new forms of engines especially fitting the service required, and as long as this advance continues, new engine designs will be presented. The most difficult dynamos to be driven are those of highest power and speed. Upon speed depends many things, among them real estate, first cost of plant, fuel, maintenance, labor, etc., and the engine itself.

To illustrate this, assume, first, a 100-horse power dynamo is to be driven at 800 revolutions per minute. The requirements are either a high speed engine (say 250 revolutions per minute), driven by a belt from the engine pulley three and two-tenth times the size of the dynamo pulley (this would be poor practice), or, driving by two belts from wheels more nearly of like dimensions, two of which are mounted on the countershaft. These two methods are termed high speed and slow speed. Against the former is charged excessive use of steam in the engine itself, cost of repairs of engine, cost of oil and attendance, and in its favor credited moderate floor space, low first cost and decreased interest on buildings, ground, etc. Against the latter is charged excessive floor space, and consequent interest on buildings and ground, one extra belt and a countershaft, and an excessive frictional resistance, and in its favor is credited economy in the use of steam as far as the engine is concerned, small oil and repair bills, etc.

Summing up at the end of five years' service, the prime cost, maintenance and operating expenses of each system, taking all things into consideration, where fuel costs moderately, the balance will be found in favor of the high speed system for small plants.

In stations employing a number of high speed dynamos, the advantages are in favor of the slow speed and countershafting, and there will naturally be a certain size station in which slow and high speed would present about equal merits. The comparison would be largely influenced by the cost of fuel.

On the other hand, assume a 100-horse power dynamo to be driven at 200 revolutions per minute, the only proper method is to mount the armature on the engine shaft. A 100-horse power engine would perform nicely at 200 revolutions per minute, and be economical in the use of steam, taking very little floor space, no belts, no dirt, no noise. There would practically be but one type of engine for this type of generator.

When arc light machines can be produced, speeded in sufficient moderation to admit of direct connection engines, the problem will have been solved, which will place arc light stations on the basis of perfection. The smaller units will be driven at higher speeds, and the larger by large engines running at more moderate rates of rotation. But it does not appear that these engines could be classed a part of them as high speed, and a part of them as slow speed. As a matter of fact, in large powers high speed engines become slow speed, or slow speed engines become high speed, just as you have the mind to term it. I prefer the latter construction. It is true that the so-called slow speed engines are limited in rotative speed by a peculiarity in their valve gears to about 85 revolutions per minute, which is very slow for a small engine, and may be quite high for a large engine, say 1,000-horse power, while so-called high speed engines, being unlimited by any feature of their valve mechanism, may be driven at any rotative speed not considered beyond their power of endurance.

What are called high speed engines may be built either vertical or horizontal; likewise slow speed engines. The advantages claimed by the vertical design over the horizontal one, mainly, small floor space, decreased frictional resistances in the engine itself, admitting of higher power efficiency and greater durability, mainly on account of the pistons pressing very lightly against the walls of the cylinder, occasioning much less wear than when the weight is taken on the lower part of the cylinder, as in horizontal designs. The frictional resistances of these vertical designs in tolerably large powers have been found to measure less than 5 per cent. of the total indicated horse power.

The writer is now engaged in building two engines of 1,200-horse power each, which are to be direct connected to their generators, and are to furnish current for upward of 600 arc lights, together with incandescent and motor work. The design is vertical 3-cylinder compound, having three double cranks. The 3-cylinder plan was preferred on account of superior distribution of steam pressures, and for the reason that the power is divided upon three cranks placed at 120 degrees, like a triple marine engine. This insures a more even rate of rotation, and at the same time increases the wearing surfaces, and, consequently, durability of the wearing parts. The speed is to be 100 revolutions per minute, and the steam pressure 125 pounds.

The triple expansion engine is without question the right one for stations where water may be had for condensation. Vertical design, governed on the first cylinder only. This gives *immediate* control of about one-half the nominal capacity of the engine. Expressed differently it constitutes a 50 per cent. direct controlling power. In order to secure the most satisfactory results there should be three double cranks placed at 120 degrees. In this design all strains are taken squarely upon the bearings and it is far more durable than any other mode of construction.

Coke Ovens in the United States.

Mr. Joseph D. Weeks, according to the *Am. Manufacturer*, in his report on the manufacture of coke, which has just appeared in Mineral Resources for 1893, gives a table showing the number of coke ovens in each State and Territory on December 31 of each year from 1889 to 1893, together with the total number of ovens in the United States at the close of each of these years. The report states that in the earlier years covered

by this table some coke was made in pits and on the ground, and in testing the adaptability of certain coals to the manufacture of coke this is still customary, though in the later years but little of the coke reported as produced in the United States was made in anything but ovens.

Number of Coke Ovens in the United States on December 31 of each of the years from 1889 to 1893.

States and Territories.	1889.	1890.	1991.	1892.	1893.
Alabama.....	3,944	4,805	5,068	5,230	5,548
Colorado... ...	834	916	948	a1,128	a1,154
Georgia.....	300	300	300	300	338
Illinois.....	149	148	25	24	24
Indiana.....	111	101	84	84	94
Indian Territory	78	78	80	80	80
Kansas.....	68	68	72	75	75
Kentucky	166	174	115	287	283
Missouri.....	9	10	10	10	10
Montana.....	90	140	140	153	153
New Mexico....	70	70	....	50	50
New York.....	....	....	....	....	c12
Ohio.....	462	443	421	436	435
Pennsylvania...	22,143	23,430	25,324	25,366	25,744
Tennessee.....	1,639	1,664	1,995	1,941	1,942
Utah.....	34	80	80	83	83
Virginia.....	550	550	550	594	594
Washington....	30	30	80	84	84
West Virginia..	3,438	4,060	4,621	5,843	7,354
Wisconsin.....	50	70	120	120	120
Wyoming.....	0	20	24	24	24
Total.....	34,165	37,158	40,057	42,002	44,201

a Includes 36 gas retorts. *b* Coke made in pits. *c* Semet-Solvay ovens.

As compared with 1892 the above table shows an increase in the number of ovens in the United States of 2,199. The great increase in the number of coke ovens was in West Virginia, in which the number increased from 5,843 ovens in 1892 to 7,354 ovens in 1893, an increase of 1,511. The number in Pennsylvania increased from 25,366 ovens in 1892 to 25,744 in 1893, an increase of 378. The number of ovens in Alabama increased from 5,320 in 1892 to 5,548, or 228. These are the only States that showed any important increase in the number of ovens. As we have noted in previous volumes of this series, a calculation based upon this table and the one showing production indicates that the ovens in certain States were in much more active operation during the year than those in other States. For example, though Alabama had but 5,548 ovens, as compared with 7,354 in West Virginia, it made nearly 110,000 tons more of coke, showing that the product of coke per oven during the year in Alabama was greater than in West Virginia. The product per oven in West Virginia in 1893 was 144 tons; in Alabama 211 tons; and in Pennsylvania 242 tons.

Most of the ovens in operation in the United States are of the solid wall type, in which the coal is coked by heat generated in the oven itself, a certain amount of heat generated at a burning being stored in the walls of the oven. Most of the ovens are of the regular bee-hive shape; a few are somewhat modified in form, the oven being long and shaped like a muffle. The principle of coking, however, is the same in these long ovens (which are sometimes called Welsh ovens or drag ovens, certain shapes used in this country being also known as the Thomas oven, from its inventor) as in the bee-hive; that is, the coking of the coal is by the heat generated by the combustion of the coal in the oven itself with such slight heat as may be stored in the walls of the oven from a previous burning. Some flue ovens were in operation in the United States in 1893, and a bank of Otto-Hoffman ovens was contemplated. In the term flue ovens are included all ovens in which the coking operation is performed in whole or in part by heat applied externally to the inner wall of the oven by means of the waste gases which are burned usually in flues contained in the walls of the ovens. There is a great demand in this country for tar and ammonia water which the illuminating gas works are not able to supply, especially in view of the fact that the amount of these by-products has been considerably lessened by the use of enriched water gas. It is believed that there are certain coals in the United States which are largely used in coke making at the present time the coke from which would be very much improved and the cost of production very much reduced by the use of some form of flue oven with the saving of by-products.

The production of coke in the several States and Territories from 1890 to 1893 is shown in the following table:

Amount of Coke Produced, in Short Tons, in the United States, 1890 to 1893, Inclusive, by States and Territories:

States and Territories.	1890.	1891.	1892.	1893.
Alabama.....	1,072,942	1,282,496	1,501,571	1,168,085
Colorado.....	245,756	277,074	365,920	346,981
Georgia.....	102,233	103,057	81,807	90,726
Illinois.....	5,000	5,200	3,170	2,200
Indiana	6,013	3,798	3,207	5,724
Indian Ter....	6,639	9,464	3,569	7,135
Kansas.....	12,311	14,174	9,132	8,565
Kentucky	12,343	33,777	36,123	48,619
Missouri.....	6,136	6,872	7,299	5,905
Montana.....	14,427	29,009	34,557	29,945
New Mexico..	2,050	2,300	0	5,803
New York....	0	0	0	12,850
Ohio....	74,633	38,718	51,818	22,436
Pennsylvania.	8,560,245	6,954,846	8,327,612	6,229,051
Tennessee	348,728	364,318	354,096	265,777
Utah	8,528	7,949	7,309	16,005
Virginia.....	165,847	167,516	147,912	125,092
Washington..	5,837	6,000	7,177	6,731
West Virginia.	833,377	1,009,051	1,034,750	1,062,076
Wisconsin. ...	24,976	34,387	33,800	14,958
Wyoming	0	2,682	0	2,916
Total.....11,508,021		10,352,688	12,010,829	9,477,580

The relative rank of quite a number of the States, as coke producers, changes in 1893. Ohio, which held 8th place for a number of years, has fallen to the 10th. New Mexico, which has been 19th or 20th, has risen to the 18th place, while Illinois, which has been the 17th and 18th, has dropped to the 21st place. Kansas has dropped from 12th to the 14th place; Indiana from the 17th to the 19th place. Kentucky has risen from 9th to the 8th; Indian Territory from the 16th to the 15th place, and Montana from the 10th to the 9th place; Missouri has dropped from the 14th to the 17th place; Wisconsin from the 11th to the 12th place, and Wyoming from the 19th to the 20th.

In the following table is given the total value of coke produced in the United States in each year from 1890 to 1893, inclusive.

Total Value at the Ovens of the Coke Made in the United States, from 1890 to 1893, Inclusive:

States and Territories.	1890.	1891.	1892.	1893.
Alabama.....$2,589,447		$2,986,242	$3,464,623	$2,648,632
Colorado.....	959,246	896,984	a 1,234,320	a 137,488
Georgia.....	150,995	231,878	163,614	136,089
Illinois....	11,250	11,700	7,123	4,400
Indiana.....	19,706	7,596	6,472	9,048
Indian Ter.....	21,577	30,483	12,402	25,072
Kansas.....	29,116	33,296	19,906	18,640
Kentucky.....	22,191	68,281	72,563	97,350
Missouri	9,240	10,000	10,949	9,735
Montana	125,655	258,523	311,013	239,560
New Mexico....	10,025	10,925	0	18,476
New York.....	...	....	....	35,925
Ohio.....	218,090	76,901	112,907	43,671
Pennsylvania..	16,333,674	12,679,826	15,015,336	9,468,036
Tennessee	684,116	701,803	724,106	491,523
Utah.....	37,196	35,778	....	....
Virginia.....	278,724	265,107	322,486	282,898
Washington....	46,696	42,000	50,446	34,207
West Virginia..	1,524,746	1,845,043	1,821,965	1,716,907
Wisconsin.....	143,612	192,804	185,900	95,851
Wyoming.....	0	8,046	0	10,206
Total.....$23,215,302		$20,393,216	$23,536,141	$16,523,714

a. Includes Utah's production.

While this table gives the totals of the values as returned in the schedules, the figures do not always represent the same thing. A statement as to the actual selling price of the coke was asked for, and in most cases, including possibly 80 per cent. of all the coke produced, the figures are the actual selling price. In some cases, however, the value is an estimate. Considerable of the coke made in the United States is produced by proprietors of blast furnaces for consumption in their own furnaces, none being sold. The value, therefore, given for this coke would be an estimate based, in some instances where there are coke works in the neighborhood selling coke for the general market, upon the price obtained for this coke; in other cases the cost is estimated at

the cost of the coke at the furnace, plus a small percentage for profit on the coking operation, while in still other cases the value given is only the actual cost of the coke at the ovens.

An inspection of this table shows the value of coke in 1893 to range from $1.50 a ton in Georgia to $8.00 a ton in Montana. These high prices are not always arbitrary, the character of the coal in Montana and Washington, where the highest price rules, the higher price of labor and the other elements of cost rendering the manufacture of coke in these districts not as remunerative as the price given would indicate.

The Engine in the Central Station.

By MR. E. A. MERRILL, in *Electrical Engineering*.

The fundamental principle running through all modern central station design is *economy*—economy in first cost and economy in operating expenses—and to attain the highest economy the central station must be looked at as a unit in itself; the constituent parts being considered in their relation to each other quite as much as the units by themselves. An efficient dynamo, an efficient engine, an efficient boiler, not only does not in itself make an economical station, but its efficiency may entirely disappear through combination with some wholly unsuitable dependent part. Efficiency is everywhere a relative term, and nowhere in the central station equipment is it, perhaps, more apparent than in the engine, especially in the larger sizes.

Have you ever asked yourself seriously the question, "What is a 500-horse power engine?" If you have not, you will find in it plenty of food for a half hour's reflection, simple though it sounds. For example, the same engine may develop 400-horse power, 500-horse power, or 600-horse power at its most economical point of cut-off; but with varying conditions of speed and steam pressure to suit local conditions or prejudices, is it a 400-horse power, a 500-horse power or a 600-horse power engine?

And the conditions having determined the rating, what is the most economical generator capacity to combine with it? Shall the capacity be the same whether the generator be belted or direct connected? Shall the capacity be the same whether its duty be incandescent lighting, arc lighting or the transmission of power?

It is in the answers to the above questions that we shall find the measure of engine economy in the central station.

A great many purchasers make a fundamental mistake in assuming that an engine is rated after the manner of a generator, namely, a reasonable amount below its maximum capacity. In the generator this generally *is* true; in the engine it *may be* true, but it is not a safe assumption to work on, as the error sometimes lies on one side and sometimes on the other.

An engine designed to give 500-horse power non-condensing under certain conditions of pressure, cut-off and speed may develop 600-horse power, run condensing, and therefore would be so rated; but the fact remains that it is *not* a 600-horse power engine unless its working parts are designed to continuously carry that load—its actual rating is an accident due to circumstances.

But supposing it to be designed for developing 500-horse power continuously and 600-horse power occasionally, what kilowatt capacity can it most economically take care of?

It is on this point, probably, more than upon any other, that the average purchaser errs and materially reduces the economy of his station by mistakenly supposing that the larger the cylinders, and the higher the possible rating, the more he is getting for his money and the better the engine will take care of an *occasional overload*. This is in exact opposition to economy, for the larger the cylinders in proportion to the load the greater will be the consumption of steam per horse power and per hour, and the consumption is greater for a given percentage of underload than for the same percentage of overload.

The most satisfactory solution known to the writer is to figure the cylinders (as closely as circumstances will permit) to give the most economical point of cut-off at the *average* load, and then put those cylinders on frames that will safely take care of the *maximum load*, the governor taking care of the cut-off. Thus, if the generator is of 300 kilowatts capacity, and practically loaded full all the time, put 450-horse power cylinders on a 500-horse power frame; if the generator has an average load of 300 kilowatts and a maximum load of 400 kilowatts, put 450-horse power to 500-horse power cylinders on a 650-horse power frame.

We thus combine the highest economy in steam consumption with the least cost for maintenance and repairs. For example, in a certain station where the load fluctuates widely, four engines nominally rated at 400-horse power each are operated for short periods each day at 550-horse power each and have indicated 650-horse power, the results in coal consumption and maintenance have fully justified the combination of comparatively small cylinders with large shafts, ample wearing surfaces, heavy flywheels, and stuffing boxes, pistons, etc., to carry 180 pounds initial steam pressure when required. In another station engines nominally rated at 700-horse power are daily indicating at certain hours from 800-horse power to 1,000-horse power, and have been worked to 1,100 horse power; so far as the writer knows, their economy in coal consumption has not been equaled in any other station working under the same general conditions. Under such circumstances the "*occasional overload*" loses its "bug-a-boo" aspect.

Although these are, perhaps, unusual cases, they nevertheless show that cylinder dimensions are a poor criterion by which alone to judge the value or economy of an engine. Thus in the case above cited 1,000-horse power cylinders might have been put on the same frames at a merely nominal increased cost and the purchaser assured that he was getting engines of 50 per cent. greater capacity at the same price, whereas, as a matter of fact, it would be money out for him every day the engines were operated.

On a steady arc light load the conditions are changed, and here the cylinders should be designed to have about the same capacity as the frame, and only sufficiently in excess of the kilowatt capacity to take care of internal and intermediate losses, say 500-horse power at its most economical rating for a capacity of 300 kilowatts, the arc dynamos requiring somewhat more power than the corresponding capacity in incandescent dynamos.

There will be found, however, necessary differences in cylinder dimensions, due simply to differences in types of governing mechanism. For example, the cylinders of a releasing valve-gear engine having a maximum cut-off one-half, must be considerably larger, to take care of a given maximum load, than the cylinders of a positive motion valve-gear engine having a maximum cut-off of $\frac{8}{10}$, and this reduces the economy of the former on variable loads, as it is working for a greater proportion of the time than the latter at the less economical points of cut-off.

The proportions of cylinders and frames to load determine the economy in steam consumption and the life of the engine; the details of proportion in individual parts, accessibility, auxiliary devices for securing proper lubrication, cool running, etc., are also important as securing economy in time in making renewals, taking up wear, and in the easy running of the engine.

To summarize: The true value of the central station engine cannot be estimated by its price or its rated horse power alone, but it must be looked at first in its relation to its work, second in the relation of its own parts to each other, and third with reference to the devices for insuring uninterrupted operation and the greatest accessibility of working parts.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Capital Gas Company, of Sacramento, Cal., has levied a second assessment of $5 per share, amounting to $50,000, the delinquent date for which is fixed for the 31st inst. The proceeds of the two assessments are to pay for the restoration of the Company's electric lighting plant, which was destroyed by fire last April. The first assessment was paid in with remarkable promptness.

AT the annual meeting of the Bridgeton (N. J.) Gas Light Company the following officers were chosen: Directors, Daniel Elmer, H.W. Elmer, Chester J. Buck, William C. Mulford and Daniel Bacon; President, Daniel Elmer; Secretary and Auditor, William C. Mulford; Treasurer and Superintendent, B. F. Harding.

THE answer filed by the Louisville Gas Company in the suit of Dulaney & Alexander, whose complaint will be found in our item columns for July 2d, who secured an injunction restraining the Company from shutting off their gas, is to this effect: The Company denies that plaintiffs were compelled to use gas, as they could have used candles, kerosene or electricity; that 10 cents per month is a reasonable rent for a meter, and that they use less than 500 cubic feet of gas per month in their premises, which makes the meter charge a necessity in order that the Company may light complainants' offices without loss to itself.

GEORGE T. MILLER, of 42 Michigan avenue, Detroit, has called the attention of the Mayor and Common Council to a grievance that he holds against the Detroit Gas Company, and asks for relief. He applied for gas for fuel and lighting purposes, and was told that he must deposit a certain sum of money with the Company as security for the payment of his monthly bills. He offered to pay a month in advance, but the Company refused to furnish him with gas, except upon the conditions

named. He paid his bills for May and June, and then demanded the return of his deposit, but the Company insisted that the deposit must remain in its custody until he ceased to be served by it. He also claims the Company will not allow him any interest on the deposit. The Company in return sets up the defence that through a decision of the Supreme Court (Williams vs. The Mutual Gas Company, of Detroit) it has the right to demand security of the nature required in the case in dispute.

THE Webster Gas and Coal Company has been incorporated at Pittsburgh, Pa., by Messrs. Joseph F. Mayhugh, Allison S. Moorhead, William A. Somers and James McLaren.

THE plant of the Monongahela Electric Light and Power Company, of Homestead, Pa., was recently sold at auction, by the Receiver, at the instance of the creditors. It was bought in by the General Electric Company, at its bid of $15,000.

AT the annual meeting of the Binghamton (N. Y.) Gas and Electric Company, the officers elected were: President, J. W. Manier; Vice-President, S. J. Kirschman; Secretary, John Anderson; Treasurer and Manager, W. G. Phelps.

THE United Gas Improvement Company's bid for the public lighting of Bayonne and Greenville, N. J., is as follows: Gas street lamps, $18.50 each per annum—provided not less than 800 lamps were maintained; gas to public buildings, $1.25 per 1,000 cubic feet.

THE Akron (Ohio) City Council has passed an ordinance granting to the Akron Gas Company a franchise for a period of 10 years, the price of gas to be $1.35 per 1,000 cubic feet to ordinary consumers, and $1.20 per 1,000 to the city, until the consumption shall have reached 40,000,000 cubic feet per annum, when the prices shall be $1.25 to ordinary consumers and $1.10 to the city.

THE Board of Gas and Electric Light Commissioners, of Massachusetts, gave a hearing in the office of the County Commissioners, of Worcester, on the 11th inst., on the petition of Mayor Henry A. Marsh, of that city, pursuant to a vote passed by the City Council, asking for an equitable adjustment of the price of the gas furnished by the Worcester Gas Light Company, and for such other action as might be necessary tending to a reduction in the price of gas and the improving of its quality. The Commissioners present were Chairman Forrest E. Barker, Gen. Schaff and Chas. H. Gifford. City Solicitor Hopkins represented the city and Senator Hoar appeared for the Company. Mayor Marsh was present throughout the proceedings. In opening the case for the petitioners, Col. Hopkins said the scope of the question was large. He declared that in such case the Board was competent to take cognizance of the price of gas, and that, so far as he knew, the question of the quality of the gas might not be considered—at least so far as its brilliancy was concerned. As to the composition of the gas, he believed there was much entering into it besides coal, making it possibly water gas instead of coal gas. Having stated the price of gas and the discount allowed for prompt payment, he said that people of Worcester claimed that the price is too high. The plant of the Worcester Company ranked third in the State and has all facilities for large production. The Superintendent of Street Lighting had prepared a report as an expert, which would be presented to the Board, and that report showed that of the Companies in the State making 30,000,000 cubic feet annually, Worcester was charged the highest price. Under its agreement with the city the Company was obliged to furnish gas at as low a price as that which ruled in Boston, Baltimore or New York, and the Supreme Court had decided that the city had the right to enforce this clause in the charter. Henry T. Knight, Superintendent of Street Lighting, testified that while the average price of three leading Companies of Massachusetts had been $1.72 for the fiscal year ending June 30, 1886, the net price in Worcester that year was $2. In 1887 the average price charged by those three Companies was $1.66; the net price in Worcester was $1.92; 1888, average price of the other three Companies, $1.56; in Worcester, $1.82; 1889, $1.45; in Worcester, $1.51; in 1890 the figures were $1.39 outside and $1.50 in Worcester; in 1891, outside, $1.31; in Worcester, $1.50; in 1892, outside, $1.38; in Worcester, $1.50; 1893, outside, $1.27; in Worcester, $1.50. Last year the price was lowered to $1.40. The Company has an average daily producing capacity of 1,500,000 cubic feet—a capacity only exceeded by two other Companies in the State. The quality of the gas Mr. Knight believed to be all right, but he thought the Company could afford to sell it for less money. The use of gas for street illumination had been materially reduced of late years. Ald. Coombs, Chairman of the Commitee on Street Lighting, said if the price was reduced there would be an increased demand for gas. A 25-candle incandescent electric light costs the city $24 a year, while the gas lamps cost $28 per year. Mr. E. R. Ware said, with a fair reduction in the price of gas, the output of the same would be largely increased. He was interested in a gas cooking apparatus, with which, if he could secure gas at $1 per 1,000, he could compete with coal at $6.50 a ton. The Reverend John Gregson said, at the present rate nobody but a millionaire could use gas for cooking purposes. Senator Hoar, in opening the case on behalf of the Company, claimed the citizens were getting their gas cheap when compared with the past. No complaint had been made against the Company by the local press, the manufacturers of the city, or large holders of improved property; in fact, the hearing was mainly caused by the complaint of Mr. David F. O'Connell, who is not a large consumer of gas. In 1885, when the Gas Commission was organized, every Company was put under its charge, and the law at the present time gives the Commission absolute authority to act. The various cities and towns are simply agents of the State. He said that the Gas Company was not only to furnish gas to the city, but also to the citizens; yet the citizens are not bound to take gas. The Commission has the power to change the price. The question, he conceded, was a public one. The Gas Company is performing a public function, for the lighting of a street is a public function. In fact, the price of gas seemed to him to be as much of a public question as fixing rates on railroads. He claimed that unless the people had left the Gas Companies in charge of the special Commission, no reduction from $2.50 to $1.50 or $1.40 would be made. All would agree that the public should be protected against exorbitant rates, and, secondly, the power vested in the Commission should be exercised justly. He would desire that all these corporations be rewarded for their services, and it was in the interest of the city that it had a Gas Company which was responsible for its contracts. It was for the public interest that the Worcester Gas Company should expand. He saw the first gas jet lighted at the corner of Main and Pearl streets, when the city's population was 15,000, whereas now there are 100,000 people to serve. If a gas company was dealt with justly it would be able to make extensions in new territories. He said it should be taken into consideration that the making of gas is a hazardous undertaking, and for that reason a gas company must be an insurer. He said that 50 per cent. of the street lighting business had been taken from the Gas Company, although he did not deny that the people had a right to take advantage of competition and of the more recent improvements. With the advance of electricity the gas business may be doomed to perish. There had never been a time in the history of Worcester when the citizens demanded of the Company a reduction that would endanger the stability of the Company in its efforts to maintain a good standard. The plant of the local Gas Company has been honestly acquired and is fairly its own. Its workings have always been open to the public. When the Company was founded 10 per cent. dividends were the order of the day. The stock of the Company sells to-day at the rate of 160, and pays 8 per cent. dividends. This, Senator Hoar said, shows how well the Company had been managed. To fix the price of gas the Company should be enabled to give a reasonable profit on its investment, and the Commissioners were asked to take into consideration the fact that the business was a hazardous one. Senator Hoar told of the debt of nearly $100,000 incurred in the recent changes in its plant suggested by the Gas Commission, and said that provision must be made to pay it. In 1893, when the price of gas was reduced, the sales were actually decreased instead of increased. At this point the hearing was adjourned until 2:30 P.M. After the recess, proceedings were re-opened by Colonel Hopkins, who said that the city of Worcester had no idea of wrecking the Worcester Gas Company; on the other hand, Worcester wanted a Gas Company that was progressive and solvent and which could meet all its obligations. The Worcester Gas Company, in order to keep up with the times, must pay due attention to the rights of the public; and it did look as if the Company had been somewhat neglectful in this respect, for the price of gas had not been reduced in Worcester proportionate to the reductions in other cities of the State. At this point, Mr. O'Connell wanted to know why this state of affairs was permitted to exist, and Colonel Hopkins replied that was for the Gas Commissioners to explain! He (Col. Hopkins) had set the ball in motion, and he thought the time had come when a reduction should be ordered. To impress this fact upon the minds of the Commissioners he did not care to present before that body a large number of citizens to testify to that [the only citizens present seemingly were the Rev. Mr. Gregson, the man with the gas stove for sale—Mr. Ware—and Mr. O'Connell.] Worcester wanted cheaper gas, and it looked to the Commissioners for relief. Reference was made by Senator Hoar to the

fact that the Commissioners had decided not to order a reduction in the Cambridge rate of $1.35 per 1,000, but Colonel Hopkins said that the Worcester rate was 5 cents per 1,000 higher, whereas it ought to be in all fairness 15 cents per 1,000 lower. The Commissioners are asked by the remonstrants not to reduce the price because of the fear that electricity might eventually supersede gas, but he thought the public should not have to wait, and the Commission should not be turned into a board of prophets to determine just how long a time will elapse before electricity supplanted gas. He made the proposition that if gas can be made in Boston for 77 cents per 1,000, it would seem that in Worcester the price could be less than $1.40. If the stockholders were paid 7 per cent. instead of 8 per cent. no great damage would result. If a decision should be made it should be framed on present conditions; not that the Company in 10 years might be closed up, having gone to the wall because of competition with electricity. The duties, the figures and the rights of the hour should be considered. He (Col. Hopkins) was pleased that the city freely admitted the gas supplied was of good quality, which caused the question of price to be the only subject for adjudication. At the conclusion of the arguments the Board took the case under advisement, and a decision may be looked for at an early day.

AT the annual meeting of the Milford (Mass.) Gas Light Company the following officers were chosen: Directors, Chas. F. Claflin, B. C. Harris, J. B. Bancroft, E. L. Wires, Geo. A. Draper, N. B. Johnson, Frank H. Dutcher, J. E. Walker, I. N. Davis and L. H. Cook; Treasurer, B. E. Harris; Secretary, L. H. Cook.

THE Otto Gas Engine Works Company, of Philadelphia, has been chartered with a capital of $4,000,000.

MR. JOHN J. THOMAS, for many years connected with the mechanical department of the Philadelphia gas works, died at his home in that city on the 15th inst. He was in his 68th year, and served several terms on the 21st Ward School Board.

COL. JOSIAH BUTLER SANBORN, who at one time was quite prominent in the executive management of the Concord (N. H.) Gas Light Company, died at his home in Concord some days ago. He was born in Deerfield, N. H., Jan. 22, 1827, and was regarded as a man of good business qualifications and of undoubted integrity.

THE Berlin Iron Bridge Company, of East Berlin, Conn., has received the contract for a new electric light and power station for the Bradford (Pa.) Electric Light and Power Company. The building is 65 feet wide and 160 feet long, with brick side walls, the roof being of iron, covered with the Bridge Company's patent anti-condensation corrugated iron roof covering. When completed this will be one of the finest and most complete stations in Western Pennsylvania. The construction is entirely fireproof, no wooden material being observable anywhere.

SINCE July 1st the selling rate at Jamaica Plain, Mass., has been put at $1.80 per 1,000 cubic feet, gross, prompt payment (within 15 days) to secure a rebate of 15 cents per 1,000. This is virtually a reduction of 15 cents per 1,000, the old rate having been $2, gross, and $1.80, net.

IT is reported that the West End Gas Company, of Pittsburgh, Pa., will close out its business and go into voluntary liquidation.

THE Directors of the Leominster (Mass.) Gas Light Company have declared a dividend of 2 per cent., payable on demand.

MR. HENRY W. TRUE, Superintendent of the Natick (Mass.) Gas and Electric Light Company, has resigned that position to assume charge of the electric lighting plant at Lewiston, Me.

THE rates to be charged for gas by the Winnepesaukee Gas and Electric Light Company (the corporate title of the Company which is now completing its gas plant at Laconia, N. H.) are as follows:

Gas used for lighting only	$2 00	per 1,000
" " " cooking only	1 50	"
" " " lighting and cooking	1 70	"
" " " mechanical or power purposes	1 50	"

WORK on the Pintsch gas plant at Indianapolis, Ind., is well under way.

THE authorities of Lynn, Mass., are negotiating with the Lynn Gas and Electric Company as to terms for keeping the public lights in action every night and all night.

AT the annual meeting of the stockholders in the Consolidated Gas Company, of Baltimore, Md., 64,000 shares of stock were represented, and the proceedings were directed by Messrs. Jas. A. Gary (Chairman) and N. T. Meginnis, Secretary. The Directors elected were: E. C. Benedict, New York; W. B. Brooks, Wm. F. Burns, Bernard Cahn, Wm. F. Frick, Jas. A. Gary, John W. Hall, Henry James, D. D. Mallory, Wm. W. Spence, Geo. A. von Lingen and John E. Hurst. The two last named replace Messrs. Wm. S. Carrol and H. J. Davison. At a subsequent meeting of the Board, the following officers were elected: President, John W. Hall; Vice-President, James A. Gary; Treasurer, Joseph W. Clarke; Secretary, N. T. Meginnis.

MANY improvements are being made upon the plant of the Citizens Gas and Electric Company, of White Plains, N. Y., not the least of which is a new holder, 66 feet in diameter by 40 feet in height, to be built by the Kerr Murray Manufacturing Company, of Fort Wayne, Ind. The main system will also be largely added to.

THE "English Manager," who secured the appointment to "manage" the properties of the Salt Lake and Ogden (Utah) Gas and Electric Light Company, was due to arrive in Salt Lake on the 15th inst. After a while he will likely "permit" the public to know his name.

Resuscitation After Electric Shocks.

M. D'Arsonval, in *Comptes Rendus*, remarks: In my paper of April 4, 1887, I showed that electricity occasions death in two very different manners:

1. By lesion or destruction of the tissues (disruptive and electrolytic effects of the discharge).

2. By excitement of the nerve centers, producing the arrest of respiration and syncope, but without material injuries.

In the former case the death is final; in the latter it is merely apparent. I have proved that it is then possible to resuscitate the victim by means of artificial respiration. I have been able to sum up my numerous experiments in the following practical formula: ***A man struck by lightning should be treated like one drowned.***

Taking my stand on these facts, I have protested against the penalty of death inflicted in America under the (barbarous) name of ***electrocution***, the industrial alternating current employed in this case producing nearly always the second kind of death.

An accident which happened in the last few days—the conditions of which could be ascertained with all the precision of a laboratory experiment—has just confirmed in man what I have seen in the lower animals.

This is an account of the case as communicated to me by MM. Picou and Maurice Leblanc, two well-known electricians, eye-witnesses of the accident and restorers of the person "electrocuted."

When the accident occurred at St. Denis, the electrometer of Epinay, fixed between two of our three wires, marked 4,500 volts, and the ammeter inserted in one of them showed 750 milliamperes.

At the place where the disaster occurred the three wires are supported by a small post fixed to a wall at about six meters above the ground. The man who was struck was astride on the lower connecting bar, holding in one hand one of the conductors. He had carried with him a telephone wire which he was about to fix. This wire rested on the connecting bar and touched another of the three conductors.

The current was closed through the man, entering by one hand and escaping in short circuit by one buttock.

He had, therefore, undergone directly the whole tension (4,500 volts, frequency about 55). It is difficult to say exactly how long, but certainly for some minutes. The short circuit which he occasioned led to the production of sparks at the collector of the Epinay apparatus. The agent superintending suspected an accident and telephoned to La Chapelle to stop. All this represents a rather long time.

At this instant we were setting out from Epinay, and were already in the train, when we were informed that an accident had just happened.

About a quarter of an hour after we arrived at St. Denis; this man was still astride on the connecting bar, and no longer showed any sign of life. It was very difficult to take him down, and this operation took at least half an hour.

Following your advice we practised artificial respiration (working the arms) but at first without result. I then forced open his mouth and loosened the tongue, when his lungs began to act almost immediately. In two hours he was able to speak. He was burnt at the right hand and on the buttock. To-day he is doing well.

Some days ago they informed me again: "The injured man is doing well. It must be noted that no particular trouble, due to the passage of the current through the body, has been manifested. It is merely needful to attend to the burns."

All comment seems to me superfluous, and I merely repeat in conclusion: A man struck by electricity should be treated as if drowned.

THE AMERICAN GAS LIGHT JOURNAL

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MONDAY, JULY 23, 1894.

The Market for Gas Securities.

Consolidated again ruled weak since the time of last writing, and would-be sellers and prospective buyers are not very far apart in their respective estimates of values to-day (Friday), the opening having been made at 124½ bid, offered at 125. The event of the week was the announcement that the tunnel under the East river, which is to convey gas from Ravenswood to this city, was open—not exactly for business, but for the inspection of visitors. There is no doubt about it that the headings have been joined, and it also goes without saying that the engineers in charge of the work are entitled to great credit. Of course, the "hole" is a very damp one, as anyone who watches the pumps on the New York side can readily determine, and much remains to be done in the instances of shaping up the rock and completing the lining, to say nothing of the labor of stringing the pipes. Months must elapse before gas can pass through it; further, we imagine the tunnel itself will be a source of great standing expense to the Company. Equitable remains firm, as does Mutual, while Standard, particularly the preferred, shows no signs of weakening.

Over in Brooklyn the situation is as it has been for the past year or more, but quotations are firmly held. The Nassau and Fulton-Municipal Companies are going on with their pipe laying. Chicago gas was somewhat weaker, on the passage by the City Council of a charter for an opposition Company, but well-informed people do not think the scheme will ever amount to much practically. Baltimore Consolidated is steady, at 65 to 66.

Dyeing Leather.

MM. Hummel and Procter note that in applying basic coal tar colors to cotton, it is well known that the latter requires to be mordanted with tannic acid. In the case of leather tanned with sumac and other similar tanning matters, such preparation is of course unnecessary, not only because the leather already contains tannic acid, but because the substance of the leather itself as a protein compound has a natural attraction for the coloring matter. Nevertheless, very poor results are frequently obtained in dyeing leather, *e. g.*, skivers with the basic colors, the colors being pale or irregular. An examination of the dye liquors in these and other cases revealed the fact that the coloring matter was very largely precipitated, due no doubt to tannic acid dissolving off the leather.

Two methods of getting rid of the defect naturally occur to one, viz., to remove the excess of tannic acid present by previously steeping the leather in tepid water, or to render the excess inert by fixing it upon the leather in an insoluble form.

Both methods were tried, with the result that the second proved to be the most reliable and effective. To this end it is merely necessary to work the leather in a tepid bath (45° C.) containing the requisite quantity of tartar emetic for ¼–½ hour, then to wash, before proceeding to the dyeing operation.

By adopting this simple precaution, the dye liquors are maintained in a perfectly clear condition, and since they are invariably unexhausted, they can be used for dyeing further quantities of leather; moreover, the dyed colors are perfectly level, and many shades darker than without this preliminary treatment. The leather itself is in nowise injured, and since the antimony is in a perfectly insoluble form as a tannate, there can be no fear of injurious consequences arising in the ordinary use of such leather.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.
16 WALL ST., NEW YORK CITY.
JULY 23.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share. ☜

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	124½	125
Central	500,000	50	100	—
" Scrip	220,000	—	100	—
Equitable	4,000,000	100	185	188
" Bonds	1,000,000	—	106	108
Metropolitan, Bonds	658,000	—	108	112
Mutual	3,500,000	100	151	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	80	95
" Bonds	150,000	—	—	100
Richmond Co., S. I.	348,650	50	50	—
" Bonds	100,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	25	30
Preferred	5,000,000	100	80	—
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	105	—
Citizens	1,200,000	20	50	—
" S. F. Bonds	320,000	1000	—	101
Equity Gas Light Co	2,000,000	100	—	—
Bonds	1,000,000	—	—	—
Fulton Municipal	3,000,000	100	130	132
" Bonds	300,000		1[illegible]3	—
Peoples	1,000,000	10	—	70
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	98	100
Metropolitan	870,000	100	132	136
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	—	155
" Ctfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	138	145
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Bay State Gas Co.—				
Stock	5,000,000	50	14½	15½
Income Bonds	2,000,000	1000	60	—
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	78	—
2d " " "	3,000,000	1000	57	58
Buffalo Mutual, N. Y.	750,000	100	120	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
Chicago Gas Company.	25,000,000	100	75	75¼
Chicago Gas Light & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	81⅛	81½
Consumers Gas Light Co., Jersey City	2,000,000	100	56	59x
Bonds	600,000	1000	92	—
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	184½	187
Central, S. F., Cal			90	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt	11,000,000	100	65	66
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
Con. Bonds	.....	.....	60	—
East River Gas Co., Long Island City	1,000,000	100	—	—
Bonds	500,000	100	89¼	—
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
Hartford, Conn	750,000	25	120	128
Jersey City	750,000	20	190	200
Louisville, Ky	2,570,000	50	125	130
Laclede Gas Light Co. St. Louis, Mo.—				
Common Stock	7,500,000	100	16½	17
Preferred "	2,500,000	100	67	69
Bonds	9,034,400	1000	87	87½
Little Falls N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
New Haven, Conn		25	200	—
Oakland, Cal			42⅝	43
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Peoples, Jersey City	500,000	—	175	185
" " Bonds			—	—
Paterson, N. J		25	99	102
Rochester, N. Y.		50	80	85
Preferred			90	95
Bonds			90	95
Syracuse, N. Y.	500,000	25	—	—
San Francisco Gas Co. San Francisco, Cal.	10,000,000	100	71	71½
Washington, D. C.	2,000,000	20	240	—
Wilmington, Del.	500,000	50	180	182

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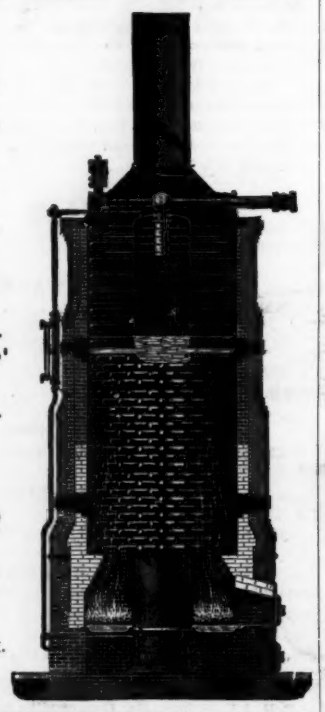

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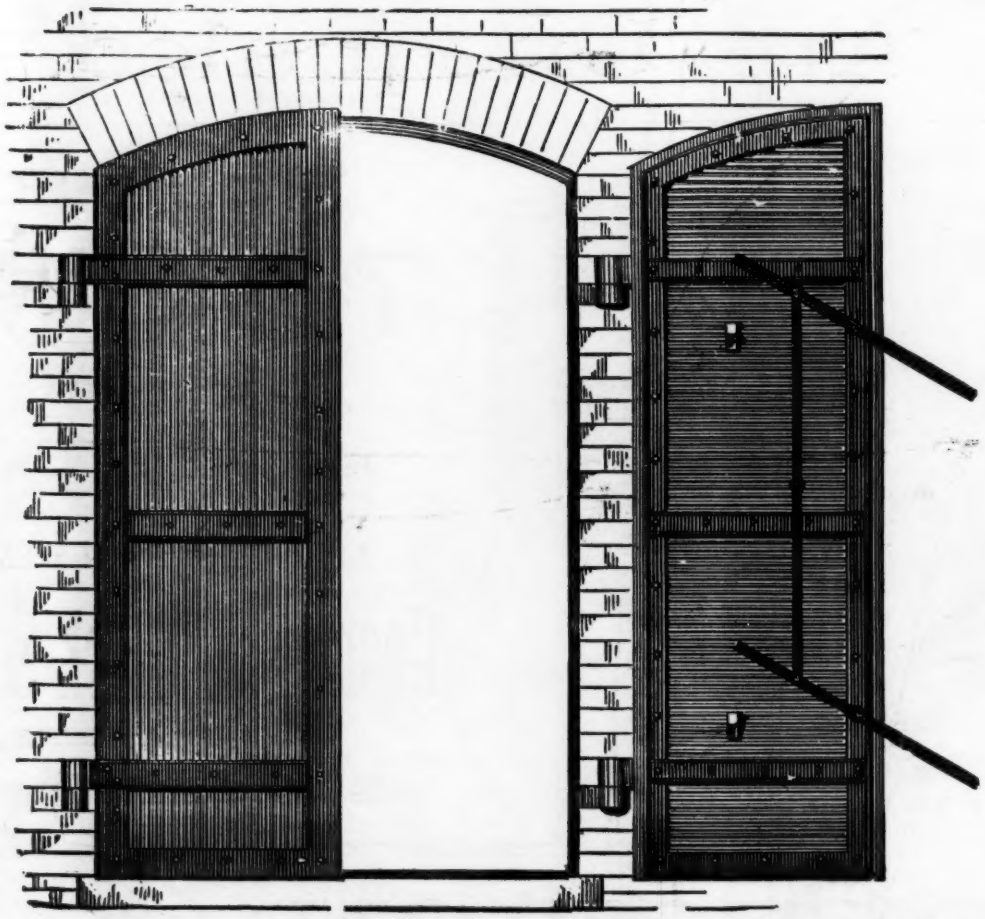

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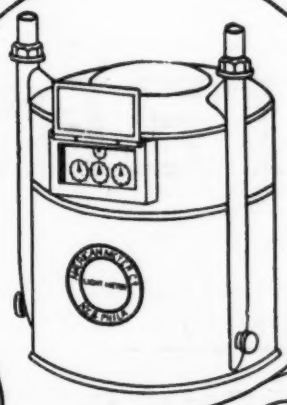

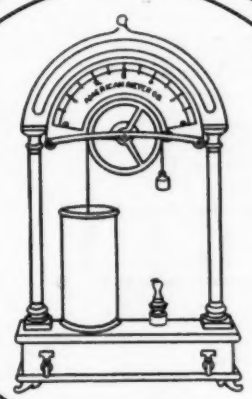

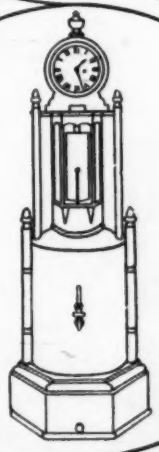

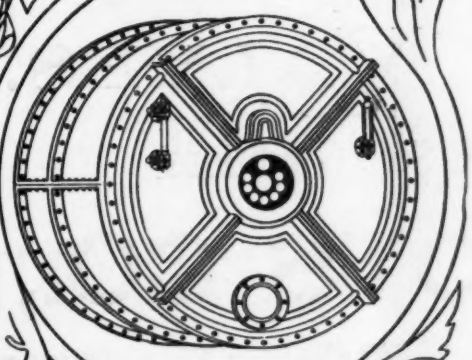

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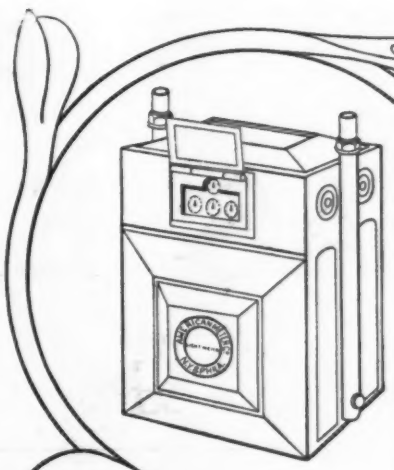
PUBLIC LIGHTING TABLE.

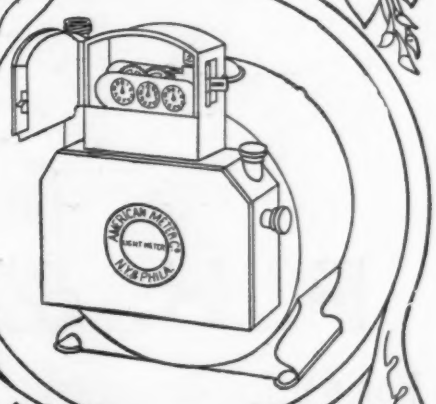
AUGUST, 1894.

Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Wed.	1	7.40 PM NM	4.00 AM	7.10	3.30
Thu.	2	7.40	4.00	7.10	3.30
Fri.	3	7.40	4.00	7.10	3.30
Sat.	4	7.40	4.00	7.10	3.30
Sun.	5	7.40	4.00	7.10	3.30
Mon.	6	9.00	4.00	7.10	3.45
Tue.	7	9.20	4.00	7.10	3.45
Wed.	8	9.50 FQ	4.00	7.10	3.45
Thu.	9	10.30	4.10	7.10	3.45
Fri.	10	11.10	4.10	7.10	3.45
Sat	11	12.00	4.10	7.10	3.45
Sun.	12	12.50 AM	4.10	7.10	3.45
Mon.	13	1.50	4.10	6.55	4.00
Tue.	14	3.00	4.10	6.55	4.00
Wed.	15	No L.	No L.	6.55	4.00
Thu.	16	No L. FM	No L.	6.55	4.00
Fri.	17	No L.	No L.	6.55	4.00
Sat.	18	7.20 PM	9.00 PM	6.55	4.00
Sun.	19	7.20	9.20	6.55	4.00
Mon.	20	7.20	9.40	6.45	4.10
Tue.	21	7.20	10.00	6.45	4.10
Wed.	22	7.20	10.30	6.45	4.10
Thu.	23	7.20	11.10	6.45	4.10
Fri.	24	7.10 LQ	11.50	6.45	4.10
Sat.	25	7.10	12.50 AM	6.45	4.10
Sun.	26	7.10	1.50	6.45	4.10
Mon.	27	7.10	4.20	6.30	4.20
Tue.	28	7.10	4.20	6.30	4.20
Wed.	29	7.10	4.30	6.30	4.20
Thu.	30	7.10 NM	4.30	6.30	4.20
Fri.	31	7.00	4.30	6.30	4.20

TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	244.10	January	423.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45





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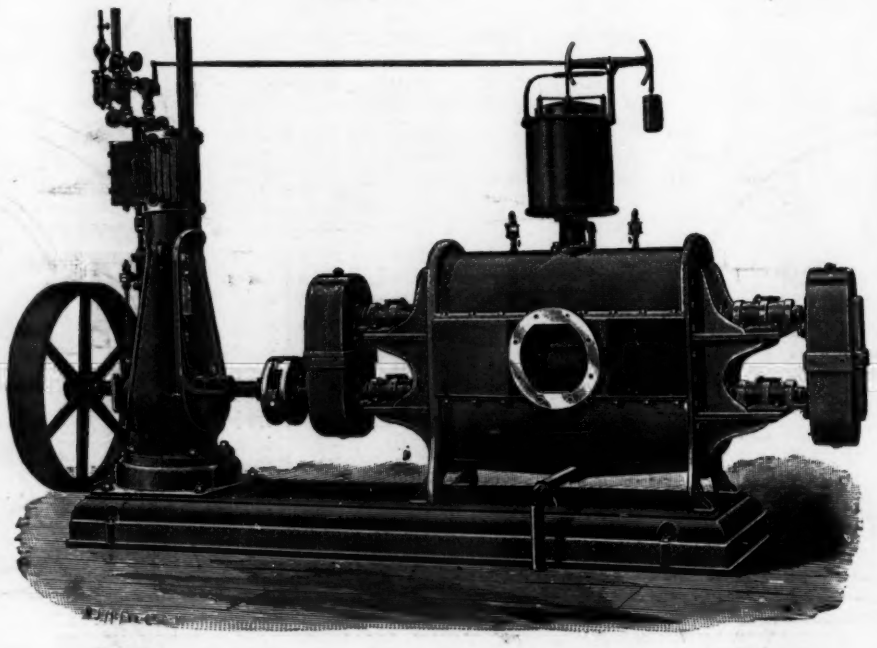

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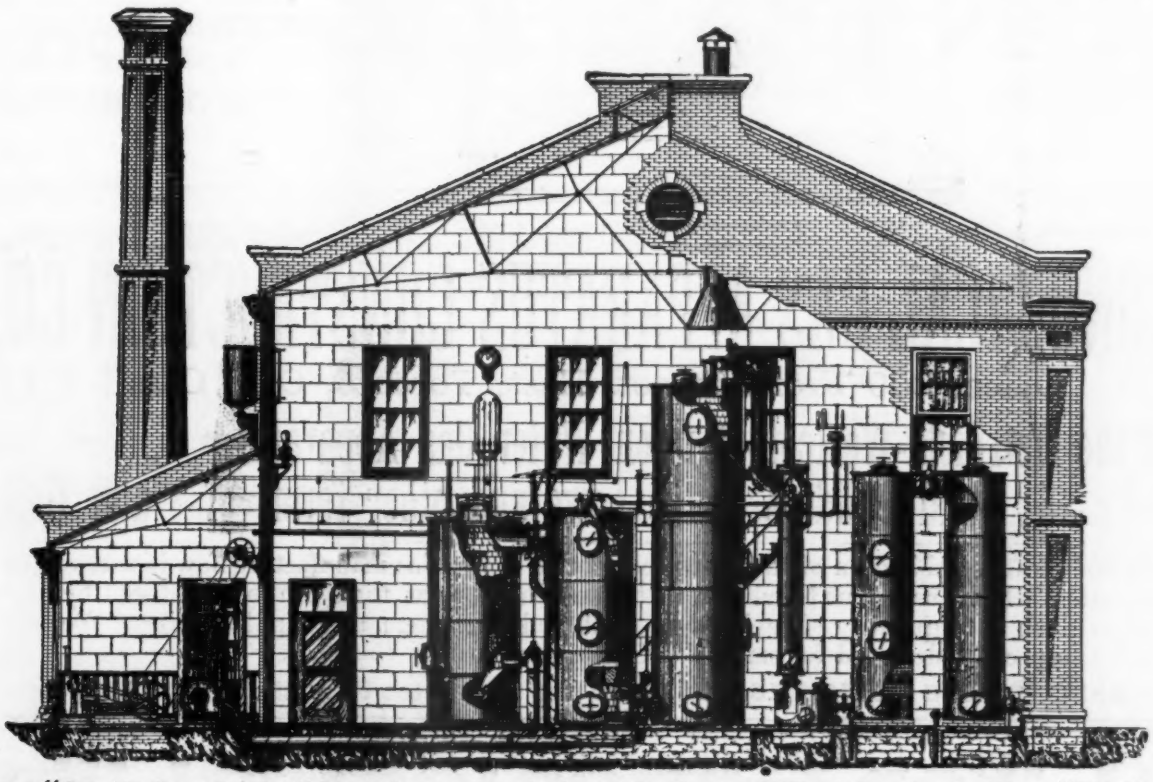

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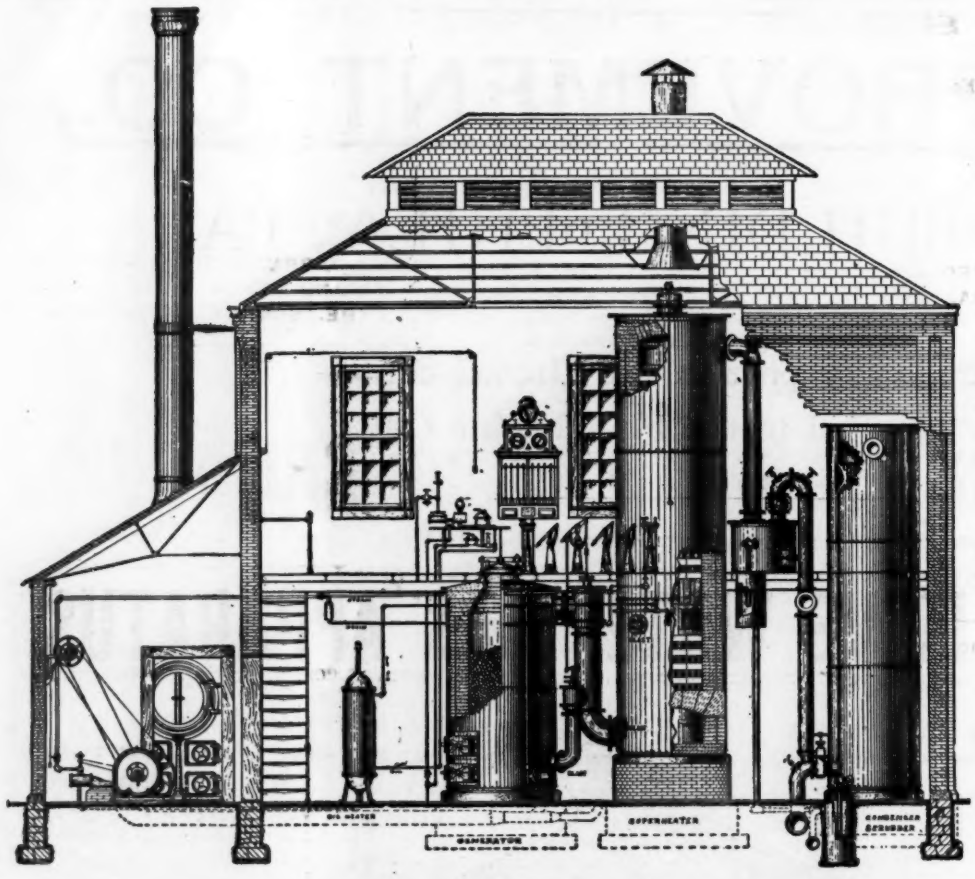

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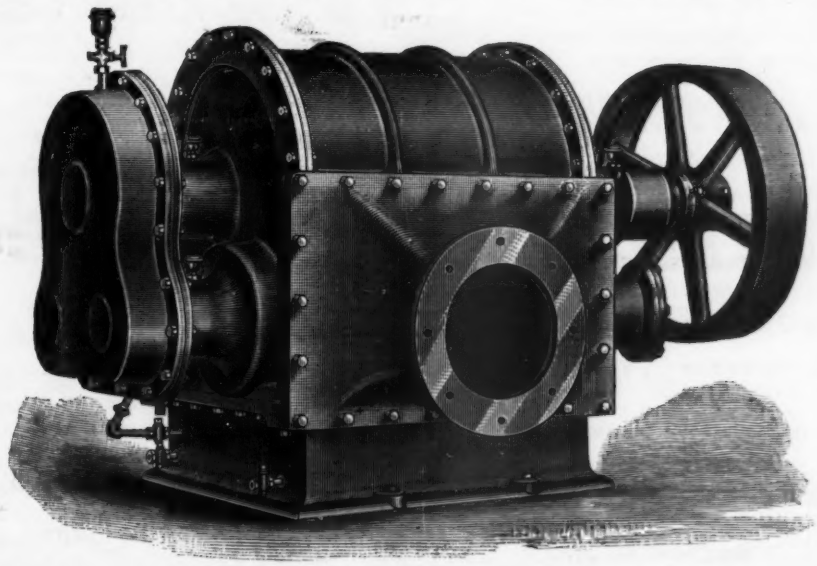

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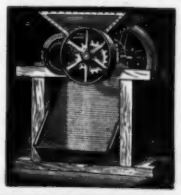

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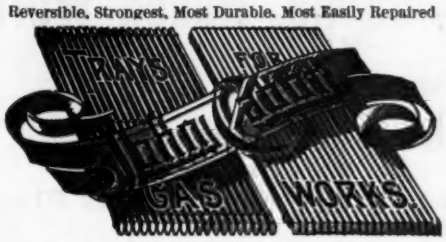

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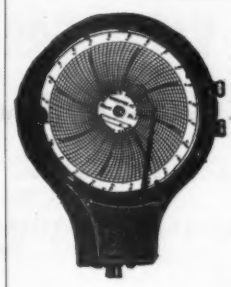

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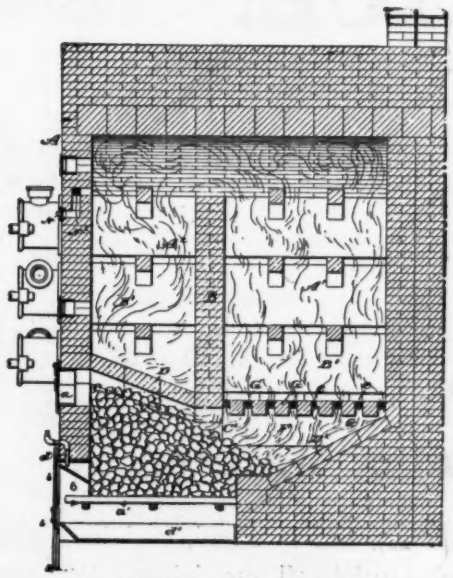

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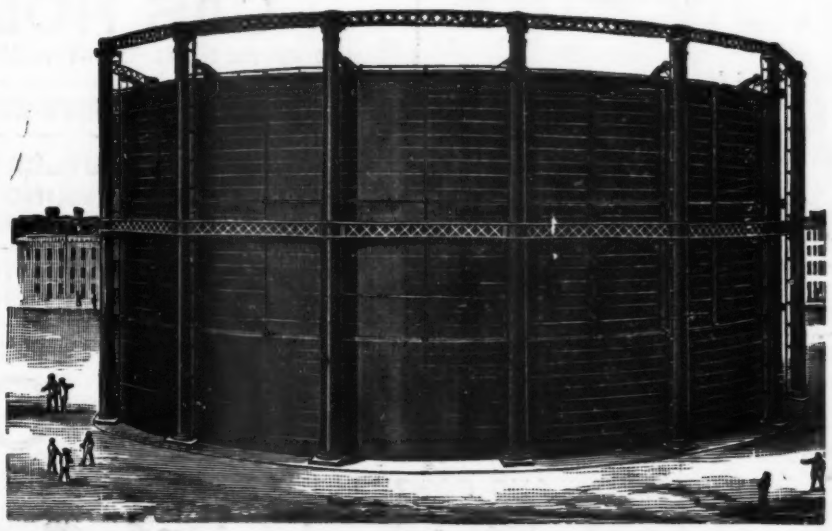

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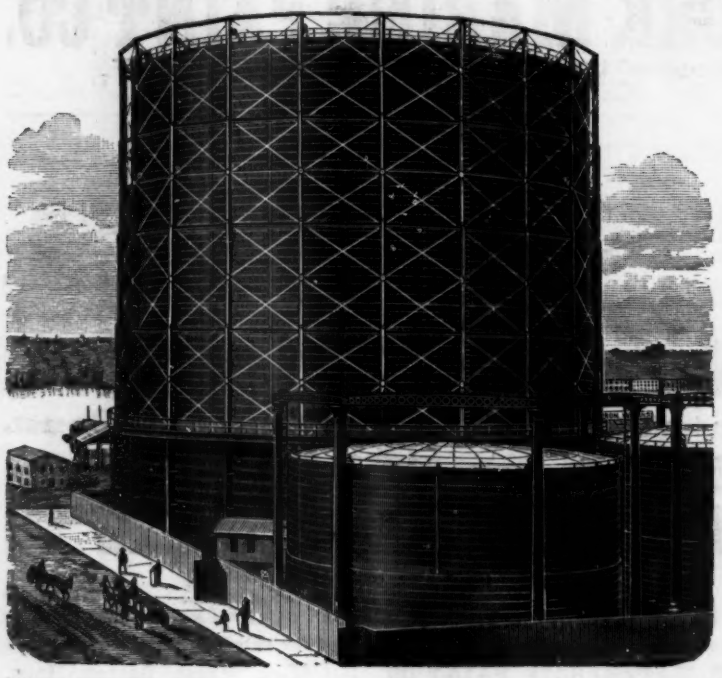

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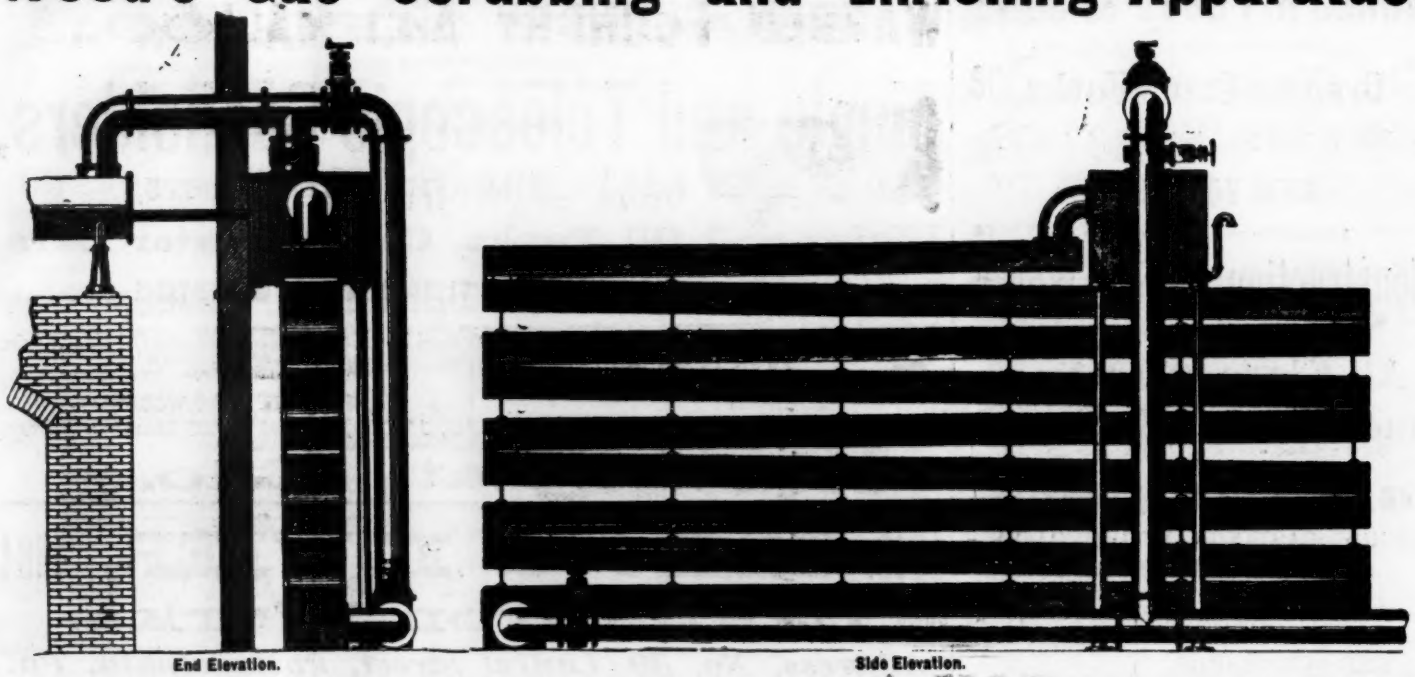

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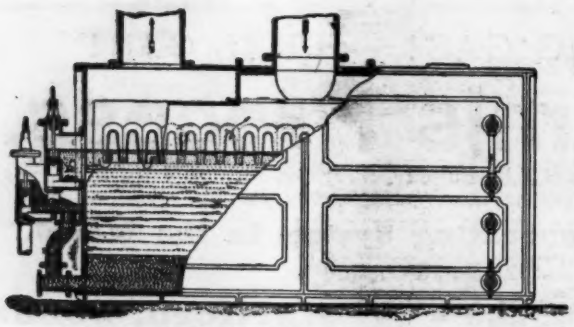

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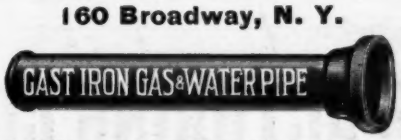

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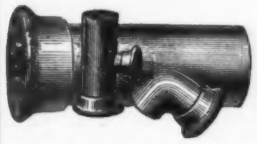

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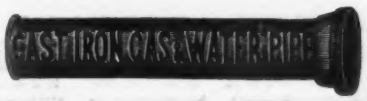

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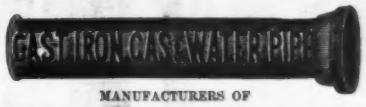

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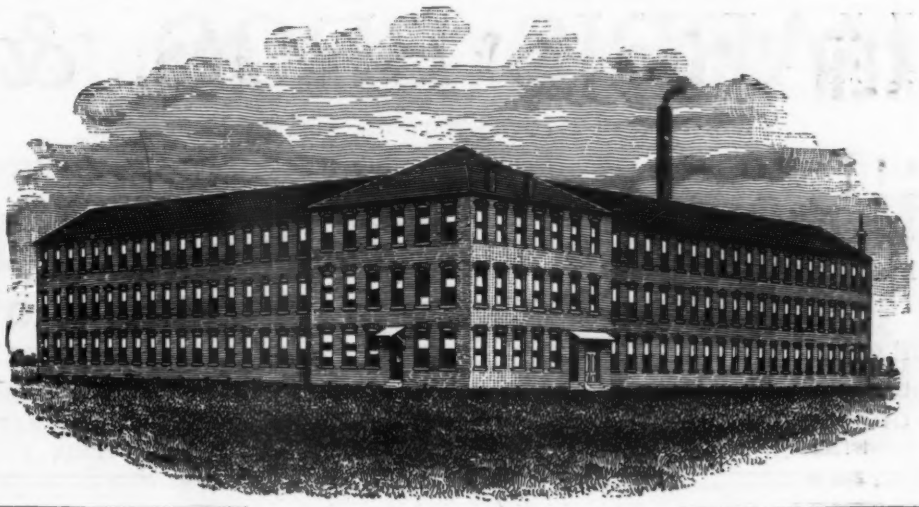

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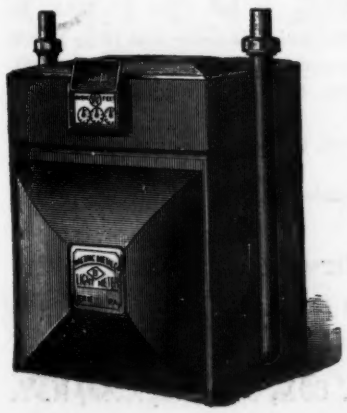

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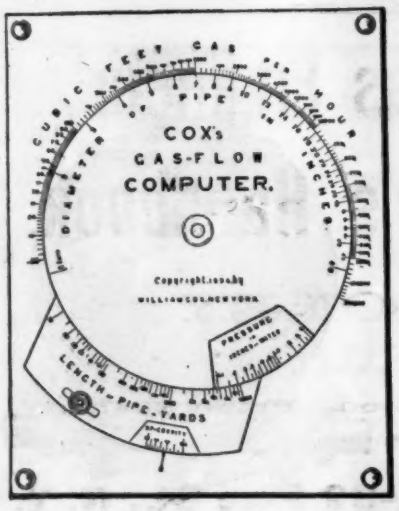

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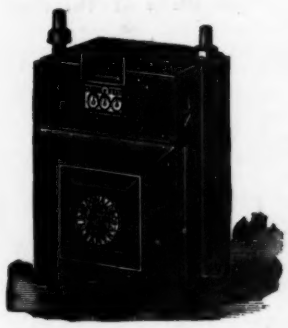

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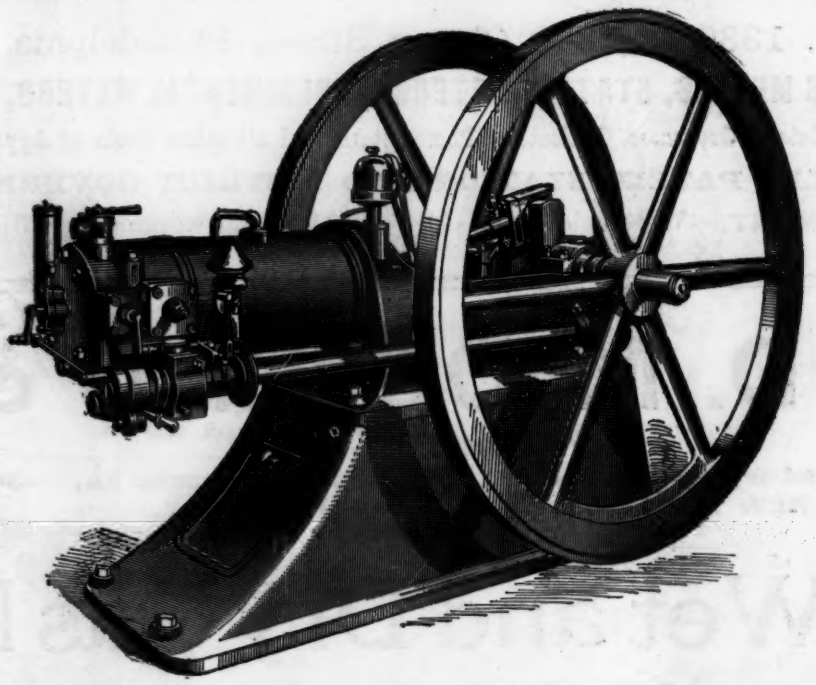

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